THE

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CONTENTS:

	PAGE
The Permanence of Aluminium in Air	89
Tramways in Large Cities	91
Telephonic Transmission (*illustrated*) (*concluded*)	92
Some Experiments on the Propagation of Hertzian Waves Along a Wire and Through the Air (*concluded*)	95
Current Specifications.—XLVI.	96
Cheaper Production and Foreign Competition	97
The Electricification of Mr. Forbes	97
The Nernst Imbroglio	98
Correspondence :—	
The Dangerous Third Rail	98
Electric Governors	99
A Two-Phase Problem	99
Legal	99
The Manufacture of Ferro-Titanium at Niagara	99
Water-Tube Steam Generators for Naval Service	100
Coal from India	101
Reviews	101
Business Notes	102
Peterborough Electricity Works (*illustrated*)	109
Economies in the Installation of Electric Tramway Plant ...	111
Supply Station Accounts	117
City Notes	118
Traffic Receipts	120
Stocks and Shares	120
Share List of Electrical Companies	121
Market Quotations	122
The Case for Electric Power Distribution (*illus.*) (*concluded*)...	123
Institution of Electrical Engineers :— The Use of Aluminium as an Electrical Conductor, with new Observations upon the Durability of Aluminium and other Metals under Atmospheric Pressure	125
Institution of Electrical Engineers (Glasgow Section) :— Practical Notes on Water-Power for Electrical Purposes (*illustrated*)	127
Large Storage Battery at Kansas City (*illustrated*)	130
Institution of Electrical Engineers (Newcastle Section) :— The Development of the Density Factor	130
Boilers in Electricity Supply Works	130
New Patents	131
Electrical Patents of 1886 Expiring July to December, 1900	131
Abstracts of Published Specifications	132

THE

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THE PERMANENCE OF ALUMINIUM IN AIR.

ON another page of our present issue we give an abstract of Mr. Kershaw's paper on the durability of aluminium wire under atmospheric exposure. For a variety of reasons the communication, though interesting, cannot be considered wholly satisfactory. In the first place, the tests did not last long enough; in the second, no complete analyses of the aluminium submitted to exposure are given; and, in the third, various statements made by the author are open to grave doubt. For instance, Mr. Kershaw asserts that the metals hitherto employed for overhead electrical conductors have been selected at random, and that no observations have been made upon their actual permanence. As a matter of fact, results of such observations have been known for many years; both the railway companies and the Post Office are well acquainted with the relative and actual durabilities of copper and galvanised iron wire under various conditions. Galvanised iron coated with tape, saturated with a preservative compound, was used 30 or 40 years ago in districts where the wire was liable to corrosion from acid fumes, but immediately hard drawn copper wire came to be manufactured, it was used in the place of the protected iron; and further, in certain cases where the atmospheric conditions are such that even copper is attacked, taped copper has been, and is, used; Mr. Kershaw must surely have been overcome by a "Rip van Winkle" sleep, not to be aware of the foregoing well-known facts. The Post Office officials have quite sufficient knowledge of the length of life possessed by copper and galvanised iron, to enable them to pass an immediate verdict upon the aluminium they are testing.

The omission of all chemical analyses is a serious defect in the paper. Except in one place, and here apparently not on the author's own responsibility, we are given no notion of the composition of the 1 or 2 per cent. of matter other than aluminium, in the wires exposed. Yet in the last edition of his standard treatise on aluminium, Dr. Richards observes that the individual and collective effect of the impurities in commercial aluminium "has not been investigated in a thoroughly satisfactory manner"; a sentence which, though four years old, is true to this day. We have before us, as we write, a series of analyses of "British" aluminium as made during 1898 and 1899. The proportion of iron ranges from 0·37 to 0·56 (mean 0·46) per cent., that of silicon from 0·34 to 0·71 (mean 0·48) per cent.; and even these figures are not sufficient for the purpose, as they do not distinguish between the two forms of silicon, combined and graphitic, found in the metal. The presence of iron in aluminium for electrical uses is presumably of much less importance than that of silicon; iron tends to harden the metal and make it crystallise more rapidly, it decreases the conductivity, but it probably exists in the form of an alloy. A small quantity of silicon is highly objectionable, and has been known for years greatly to reduce the stability of the aluminium when exposed to all

corroding agents. In the absence of precise information, we can only speculate; perhaps almost half the silicon in the aluminium exists in the elemental state, and by virtue of the electro-positive nature of pure aluminium, must lend itself readily to the formation of local galvanic couples, which give rise to the pitting in air mentioned by Dr. Richards as well as by Mr. Kershaw. Mr. Kershaw again refers to M. Ditte's researches, which led him to very pessimistic ideas as to the value of aluminium. The soundness of his conclusions was greatly discounted at the time by Moissan; and his results have elsewhere been subjected to criticism that shows they were obtained under peculiarly and unnecessarily bad conditions.

Mr. Kershaw's paper cannot be summed up more fairly than by the author himself where, omitting the word "perhaps," he says, "it is unwise to found any general conclusions upon the results of these observations." In instituting fresh tests, as we hope he will, complete quantitative analyses of the wires must be undertaken; and it would be well to study the behaviour of aluminium of the highest possible (industrial) degree of purity. Such metal might be mechanically weaker and more expensive to instal, but its extra durability might well repay its heavier initial cost. The British Aluminium Company have had similar experiments in progress at Larne (on the sea coast), at Milton (a manufacturing district with an atmosphere to match), and at Foyers (in real country) for several years; and although some of the latter wires, we understand, have been broken by snow, when the results are ready for publication, we shall no doubt have accurate analyses, and a greater period of time whereon to base our conceptions of the real permanence of Héroult aluminium.

The Lay Press out of its Element.

We took occasion in our last issue to address a few remarks to our non-technical contemporaries, pointing out the extreme absurdity of their allusions to electrical and other engineering matters. No better illustration of the ridiculous ideas entertained by some of these worthies could be wished for than the extraordinary production which we quote below, from the columns of the *Daily Mail* of January 14th :—

COPPER *v.* PLATINUM.

A series of experiments are being carried on by the Post Office telegraph officials with the object of discovering whether platinum forms a good substitute for copper in telegraph and telephone wires.

Platinum costs £130 per ton, and copper may be obtained at from £80 to £90 per ton, and its greater lightness renders it cheaper to use, and its conductivity is nearly as good as that of the more expensive metal. The tests have established the fact that the life of a platinum wire is shorter than that of a copper wire, as it is more susceptible to atmospheric action. The tests were carried out by setting up a five-mile length of platinum wire near Hanley, a neighbourhood in which the atmosphere is heavily charged with sulphurous vapours.

It has been practically decided not to use platinum wire unless some means can be found to toughen it.

No doubt the Post Office authorities have done some singular things in their time; we decline to believe, however, that they ever suggested the substitution of platinum for copper in their overhead lines! It is difficult to believe that the writer of the above is displaying such colossal ignorance as to be unaware that the cost of platinum is £4 per ounce, its specific gravity 2½ times, and its conductivity about $\frac{1}{6}$th, that of copper, and finally, that platinum is incorrodible; we are more inclined to think that in writing platinum for aluminium the writer intended having a little joke at the expense of the *D.M.*; if so, he succeeded admirably. In another part of the same issue of the *Mail*, a "hydraulic central station, evolving 20,000 volts," is mentioned, and again, the "Invasion of England" by American firms during the present year is confidently predicted, especially in the manufacture of motor cars and electrical cabs. That the junior staff of this "news" paper is not solely to blame for the twaddle of which we complain, is fitly evidenced by the following extract from *Electricity* (New York) of January 2nd :—

Mr. Alfred C. Harmsworth, proprietor of the London *Daily Mail*, who arrived in this country on December 27th, referring to the outlook for American brains and machinery in England, is reported as saying: "You have a big chance now with automobiles. We shall shortly be spending $500,000,000 converting our horse-car services to electric; you can get most of that. We must put up two or three times that amount for new suburban surface car systems for our big city. Much of that will go to the immigrant from America."

Now, the *Mail* is unexcelled in its alarums on the subject of our alleged defeat in engineering trade; yet here, if the report be true, we find the chief shareholder of the *D.M.* pointing out to our American *confrères* where to attack us, and egging them on. The *D.M.* is down on pro-Boers; let it beware lest its representative exceed even these in the betrayal of our national interests.

Work and Wages.

THE year 1900 was a good one for workpeople throughout the entire country. The official statistics which have just been issued go to prove that while there has been comparative freedom from strikes, over 1,000,000 workers have received increases averaging 3s. 9d. per head. This is a hopeful sign of greater reasonableness on the part of the worker, an attitude which, as shown by the year's results, leads employers more into the frame of mind for granting concessions where they may be found to be possible. One very interesting feature revealed in the statistics is in regard to the coal trade. Some newspaper correspondents and others have been at great pains to make us believe that although the price of coal to the consumer was very much higher, the general mass of workers were none the better off for the rise. Now these figures prove entirely to the contrary, for nearly all the workpeople employed in the coal-getting industry received increased wages, the average advance being nearly 5s. per head per week. The iron and steel workers also benefitted very greatly. It is estimated that during the last five years 80,000 iron and steel workers have gained increases averaging 8s. 4d. per week. But with the close of the year 1900, these conditions began to alter, and in some trades decreases had to be made. How far the pendulum will swing in the opposite direction during the present year it is impossible to indicate with anything approaching to accuracy. Complaints are frequently made about the high rates of wages and the increased cost of materials, and if, as some appear to believe, the great rush of engineering work of the last few years is to be followed by a contrary period, there may be reason for certain apprehensions as to the steps which may become necessary in order to aid the British manufacturer in meeting foreign competition. It is a state of things which one would like to be avoided for certain obvious reasons, but the British manufacturer should know what he can or cannot pay, and the fact that a more conciliatory attitude appears to exist on both sides leads one to the belief that both will work together for the good of national industry.

The Coming Exhibition at Glasgow.

WE hope that English electrical engineering firms are making arrangements to be well represented at the Glasgow International Exhibition. There should be an extra effort made so that if possible the error of non-representation at Paris last year may in some measure be repaired. Of all things in the world electrical engineering firms should be there in full force, showing the very best that British manufacturers can do. The various scientific and engineering congresses to be held at Glasgow this year, including those of the British Association and the Municipal Electrical Association, are things to bear in mind. It seems to us to be a grand business opportunity which should on no account be missed.

TRAMWAYS IN LARGE CITIES.

By C. H. WORDINGHAM, M.I.C.E., &c.

For a number of years, when taking their customary annual stock of progress made during the preceding year, the editors of technical journals, while having much to congratulate their readers upon with respect to electric lighting, had to deplore the stagnation with regard to the application of electric power to tramways. Some of the earliest attempts at the supersession of horse traction that were made in Great Britain met with a large measure of success, but they came to be regarded somewhat in the light of historical curiosities, and it seemed as though any further effort in the direction of electric traction would never be made in this country. In the meantime, however, the utmost vigour was displayed in America, and, not content with their own country, the Americans caused the rapid introduction of the new system into Continental countries. So rapid was the progress, that abroad it was the tram horses which assumed the historical position and became an object of curiosity.

It is not necessary to inquire closely into the cause for the slow progress made here, but in all probability it was closely connected with the fact that the working of the cars on most British lines was in the hands of companies, whose running powers either expired in a few years' time, or who were liable to be bought out within a short period by local authorities. In either case the conditions were quite unsuitable to justify their incurring the heavy capital expenditure necessary for the conversion. Whatever the cause, it appears to be now removed, and lines are being converted from horse to electric traction in practically every part of the country, the work being carried out with the enthusiasm proverbially appertaining to converts.

Capitalists have not been backward in finding the requisite funds to carry on the work, but as was the case with electric lighting, municipal authorities having satisfied themselves through the expenditure of the capital of private individuals that the business was likely to be profitable, argued that if electric traction was a paying thing to the investor, it would be a paying thing for their ratepayers, and in many instances they have determined not to let the good thing go past them.

For good or ill, the fact remains that much of electric traction enterprise is to be in the hands of municipalities. It has always been maintained by company promoters that it was impossible to confine a tramway system within the arbitrary limits of a municipality. The tramway network must be determined by geographical considerations, and inter-urban communication must be established if a full measure of success and convenience to the public were to be attained. The inherent truth of this argument has rendered it so cogent a one that municipalities have been forced to recognise it, and it was early decided for the smaller ones to band themselves together with a large one in their midst, and so form one great undertaking for the whole district. Some opposition to this vast extension of municipal responsibility was offered by Parliament, but the large municipalities have prevailed, and the arrangements have been sanctioned, with the result that schemes of the very greatest magnitude have been planned, and are in course of being carried out.

Side by side with these municipal schemes, other large schemes, embracing large portions of entire counties, have been promoted by private individuals, and one cannot doubt that in the future a network of tramways comparable with the railway network will be established, and not comparable only, but probably exceeding it in magnitude.

The changes that will be wrought by the introduction of a a means of locomotion so entirely novel in this country cannot fail to be very considerable, and of far-reaching importance.

Within the towns omnibuses will be eliminated, and the amount of use made of cabs enormously diminished, with the result that the streets will have substantially fewer vehicles in them, while the increased speed of the cars will tend also in the same direction. Heavy goods will probably be transported at night time, thus still further clearing the streets. The result of doing away with so many horses, and of relieving the streets of so many vehicles, will be to greatly diminish the amount of scavenging required, so improving the prospects of sanitation, and at the same time will admit of a much better surface to the roadway being maintained, thus facilitating the introduction of mechanically driven carts on ordinary roads, and so aiding the improvements effected by the trams themselves.

In the towns, also, the provision of a cheap and rapid means of locomotion will cause a very much larger proportion of the population to ride instead of walk, thus facilitating business, and administering to the passion for rapidity that possesses the present generation. Incidentally this will tend to diminish rather than increase the healthiness of the man of business.

Marked as will be the effects within the city itself, the outcome of the introduction of electric trams will be much greater on the belt surrounding the city proper. The worker within the city usually endeavours to spend his hours of sleep and leisure away from his business surroundings, but his choice of a home is limited by the time which it takes him to go to his work. Anything which enables a greater distance to be covered in a given time enlarges the area at his disposal. The artisan usually lives within walking distance of his work, but if he can obtain a cheap tram and a house at a lower rent, he will leave the sordid surroundings in which he has hitherto been confined, and will move further out. The clerk, the warehouseman, and the shop assistant, instead of living under the shadow of a city, will remove into the suburban belt formerly open only to his wealthy employer, while the last-named will exchange the antiquated carriages of the unpunctual suburban train, to catch which he takes his life in his hand each morning, for the comfortable, well-lighted, rapid electric car, which arrives every two or three minutes to take him to his destination. The land bordering on the city ends of the inter-urban lines will be used for the erection of property to accommodate the former city population, and those who have the foresight to acquire the land for building purposes before the ever-alert municipalities have done so will reap an abundant harvest. The portions of line between these suburban districts will be used by villagers to pay frequent visits of business or pleasure, with ease and comfort, instead of undertaking the rare and toilsome journeys formerly required.

These alterations will not be brought about without affecting other interests. Probably the chief people to suffer will be the railway companies, whose suburban traffic can hardly fail to be materially interfered with. On the whole, however, the greatest good to the greatest number will probably be effected, which is a satisfactory result if one happens to be one of the greatest number.

Having, as requested by the Editors, indulged in a prophetic spirit, it may not be unprofitable to glance for a moment at some of the problems which will be involved in attaining the millennium anticipated.

The first thing which strikes one in considering the present position of affairs is the feverish haste in which the work is being undertaken; especially is this the case with municipal authorities. They do not appear to realise the enormous amount of work which must be accomplished before their darling schemes can be put into operation, nor the difficulty and intricacy of the problems involved. It appears to be thought no great matter to establish a network of tramways, electrically operated, in as many months as it has taken years to develop present systems, and the fact is lost sight of that much of the work that is now being undertaken in so light-hearted a manner is without precedent, and is based upon very inadequate experience.

One immediate result of the impatience to have the work started has been to drive the bulk of the business out of the hands of those legitimately entitled to it into foreign channels. Orders have been placed with American and Continental firms rather than with British, not because the latter were unable to do the work as well, or even better, but because the foreign competitors were able to promise a quicker delivery, and, to their credit be it said, in many cases their promises have been punctually fulfilled. The material has been delivered, but the supposed advantage of the greater speed has been rendered entirely nugatory by other portions of the work being in a backward state, and the plant, for the early supply of which the interests of

British manufacturers had been sacrificed, has been left to rust in a railway company's warehouse.

The choice of the system of applying the electric power to the cars is one that has been hotly debated, but the initial prejudice against overhead wires has been almost completely removed, and, fortunately, practical unanimity has been arrived at. Whether the best system has been decided upon or not is a matter which many question, but in the writer's opinion there appears to be little doubt that under existing circumstances it is the correct one, though one can hardly bring one's self to believe that this is the final solution. At all events the decision, if a wise one, has been arrived at more by good luck than by good management, for it rested chiefly with a few chosen representatives from a few municipalities, who have arrived at their decision by hastily inspecting the streets of Continental and American towns more or less numerous, but who have given little thought to the engineering problems involved, nor were they able to do so.

One of the most important of these engineering problems is the question of electrolytic damage to underground works. The Board of Trade has laid down an arbitrary rule limiting the permissible drop of pressure in the tramway returns, but the Board of Trade is not infallible, and there can be but little doubt that, unless this limit is substantially reduced in practice, the evil day of destruction of pipes has only been deferred, and there will arise a condition of things in the future which is comparable with that found in so many American cities where the more lax regulations have caused the evil effects to be sooner felt. If these gloomy forebodings are likely to be realised, it is better to face the problem now than some years hence, when the damage has actually been done. The difficulties can be overcome in more ways than one, and it behoves those engineers who are laying down schemes to decide upon the best now.

It so happens that this problem has been very prominently brought before the writer during the last few years in planning out the supply of upwards of 100 miles of track situated in a single network covering a large area, and having in it portions of extraordinarily dense traffic. To those who have not gone into the matter, it is wonderful how dense the traffic may be in a large city, and how great in consequence may be the currents to be dealt with.

In a large city the number of mains for all purposes, not forgetting the electrical engineer's lead-covered cables, is stupendous, and the consequences of the damage to them by electrolysis are so appalling, that the risk of such damage must be reduced to a practically negligible quantity.

In the writer's judgment, the best, most convenient, and probably the cheapest way is to provide a large number of centres of supply independent of one another so far as the tramway network is concerned. In the problem with which he has had to deal, the writer decided upon a low pressure generating station for the densest centre and an extra high pressure system of generation with sub-stations placed only a mile apart, thus giving a greatest length of rail from any one centre of only about half a mile. Even with dense traffic the loss of pressure in the rails is inconsiderable, and it may be still further reduced with a very small expenditure to almost any desired extent.

Though the most serious, the question of feeding the rails is not the only one involved in the supply of current to the tramway network; that of feeding the overhead lines is a matter of very great importance. In the comparatively simple work which has hitherto been done, it is not uncommon to run an underground feeder alongside of the track and take tappings from it to the overhead lines at intervals, the connections being made through fuses. In the event of a fuse being blown it has to be replaced either by the driver of a car or by some person sent out from the generating station. It may be quite possible that the fault was a temporary one, and the supply might have been re-established instantly; but whatever the cause, considerable delay necessarily would result with this system. Further than this, it is an extremely undesirable thing to allow the driver of a car, even if competent, to carry out the work, and to leave his car untended. In a large city it is imperative to adopt some other system.

For a large city the system devised by the writer offers material advantages, and may be worth describing. The whole of the overhead lines are divided up into sections about half a mile long, and these sections are connected together through circuit breakers; a distinct feeder from the generating station or sub-station, as the case may be, is taken to the middle point of each section, and is connected to it directly without the intervention of either fuses or circuit breakers. The section is, however, cut in half at this point, and a lead brought down from each side, connection to the feeder being made through switches. The feeder is connected to the switchboard at the station or sub-station through a circuit breaker. When everything is working normally, the entire network is connected up to form a single whole, and all feeders are working in parallel on it, each set from its own sub-station. Supposing a fault to occur on a given section of overhead line, the circuit breakers connecting it to the adjacent sections are thrown, and also the circuit breaker on the feeder at the station. The switchboard attendant at once restores the station circuit breaker, and if the fault has been cleared it stays in, and running can be continued over the section which has been faulty. A man is then sent round to restore the circuit breakers connecting the adjacent sections to the faulty one as soon as he has satisfied himself that the fault is really cleared. If the fault was a bad one, and could not be cleared, the half section containing it can be switched off, and the good half section kept alive.

The advantages of this method of feeding are considerable. In the first place, the whole control is vested in the station, and if it be possible to run at all on the overhead line, the connection will be re-established with the minimum amount of delay, and no unskilled person interferes. Secondly, the whole of the copper in the overhead lines is used to the best advantage, the pressure is maintained more uniform, and sudden rushes of traffic in any part can be dealt with readily, while should a feeder become faulty it can be dispensed with without inconvenience.

There are numberless other matters which should be referred to in connection with electrical tramways in large cities, but it is impossible to do so in the amount of space available for an article such as this. The subject is one which deserves the most careful attention from those whose work is connected with it.

TELEPHONIC TRANSMISSION.

(Concluded from page 10.)

Section 4. — Consider the possibility of improving one of the London to Birmingham underground telephone lines by inserting inductive coils, or leaks, at each of the testing posts on the line. The line is 116 miles in length, each wire has a resistance of 6 ohms per mile, the capacity measured between a pair of twin wires is ·06 microfarad per mile, and the inductance per mile of the twin line is 1·9 millihenrys. The line has 22 testing posts at intervals of 5 miles.

For this line we may write in round numbers.

$$\begin{aligned} R &= 1{\cdot}4 \cdot 10^{12} \\ K &= \ \ 7 \cdot 10^{-15} \\ L &= 2{\cdot}2 \cdot 10^{8} \end{aligned}$$

To represent the range of harmonics of the human voice we may take $\omega_1 = 5 \cdot 10^4$ (about 8,000 per second) to represent the upper partials, and $\omega_2 = 2{\cdot}5 \cdot 10^3$ (about 400 per second) to represent the lower partials. For these frequencies

$$\begin{aligned} I_1 &= 11{\cdot}09 \cdot 10^{12} & L\,\omega_1 &= 11 \cdot 10^{12} \\ I_2 &= \ \ 1{\cdot}5 \cdot 10^{12} & L\,\omega_2 &= {\cdot}55 \cdot 10^{12} \end{aligned}$$

For a type of an inductance coil of practicable dimensions consider a ring of soft-iron wire of a total sectional area of iron 10 square cm., and of mean diameter 18 cm. This is wound with two wires in equal sections having in all t turns. One of these is to be connected in each of the two wires of the twin line. Taking the permeability of iron for small alternating currents as 183, the increase in the value of L, when this coil is inserted in the line will be $400\ t^2$. When the two wires are connected in series their total in-

ductance will have that value. The total resistance of the coil may be about $10^2\ l^2$. Cases will be considered when the coil is wound to 50, 500, and 5,000 turns respectively. We will suppose coils of this kind to be inserted at each of the 22 testing posts on the line described above, which divide it into 23 equal sections of five miles, and consider three ways of connecting them :

(*a*) Inserted in series with the wires.

(*b*) Inserted in series with the wires with non-inductive shunts of such values as to give Heaviside's distortionless line.

(*c*) Inserted as shunts or leaks across the two wires.

It will be assumed for the present, that the compound lines thus constructed are equivalent to uniform lines having the same resultant constants, and on this assumption are obtained the following results :—

Arrangement of the line.	$\omega_1 = 5 \cdot 10^4$		$\omega_2 = 2{\cdot}5 \cdot 10^5$	
	a.	$\sqrt{\frac{1}{2}\cosh 2a}$.	a.	$\sqrt{\frac{1}{2}\cosh 2a}$.
Actual line as laid without inductance coils or leaks	3·9	24·7	2·9	9·1
Actual line with non-inductive leaks to give Heaviside's distortionless line ...	8	1,500	8	1,500
A.—With 22 inductance coils inserted in series with the line :—				
(1) Each coil wound to 50 turns	3·75	21·2	2·8	8·2
(2) „ „ 500 „	1·2	1·7	1·18	1·6
(3) „ „ 5,000 „	·18	—	·18	—
B.—The same as A, but with non-inductive leaks to give Heaviside's distortionless line :—				
(1) Each coil wound to 50 turns	7·6	1,000	7·6	1,000
(2) „ „ 500 „	2·4	5·5	2·4	5·5
(3) „ „ 5,000 „	·36	—	·36	—
C.—With 22 inductance coils inserted as leaks :—				
(1) Each coil wound to 50 turns	30·5	Very large	25	Very large
(2) „ „ 500 „	4	27	8·5	2,500
(3) „ „ 5,000 „	4	27	2·8	8·2

The best solution is evidently A (2), since A (3), B (3), both bring the line within the limits where resonance will interfere.

Section 5.—It has still to be determined how far we are justified in treating the compound line as equivalent to the uniform resultant line. Consider the compound line of fig. 2, in which a twin telephone line is arranged in a circle in the

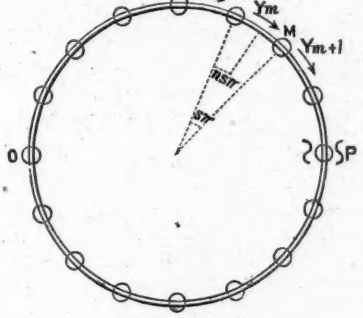


FIG. 2.

same way as that of fig. 1, except that coils are inserted at regular intervals. External alternating forces are impressed at P, and either semi-circle, such as O M P, represents a twin telephone line with inserted coils, O being the receiving end, and P the sending end. The line O M P is divided at the coils into p equal parts, each of which subtends an angle $s\pi$ at the centre, so that $ps = 1$. The angular distance along any section from one end is measured by $n\,s\,\pi$, so that the value of n in each section ranges from $n = 0$, to $n = 1$. The current in the m^{th} section is denoted by the symbol y_m, so that the sending current is $(y_p)_{n=1}$; and the received current is $(y_1)_{n=0}$. The resistance, capacity, and inductance of the semi-circle, omitting the coils, are r', K, l', defined in the same way as the corresponding quantities in the line of fig. 1. Each of the p coils is of the form of fig. 3, which is lettered to correspond to the m^{th} coil marked M in fig. 2. Each of the wires A B, C D, A′B′, C′ D′, has resistance ρ, and inductance λ ; and is an inductive resistance inserted in series with the line. The wire M N has resistance ρ', and inductance λ', and is an inductive leak between the two wires. u_o, u_o', v, are potentials at the points where the letters are placed, and x_m, x_m', y_m. y_m', are currents in the directions of the arrows. Suppose the impressed force to be of the form $Ae^{\nu t}$, where A is independent of t ; so that for every current or potential in the system, x say, $dx/dt = \nu x$.

Consider the m^{th} section in which the current is y_m. Its resistance, capacity, and inductance are $s\,r'$, s K, $s\,l'$, so that the differential equation is

$$d^2 y_m/dn^2 = s^2 \text{K}\, d/dt\,(r' + l' d/dt)\, y_m$$

$$= s^2 \text{K}\, \nu\,(r' + l'\nu)\, y_m$$

When $n = o$, $y_m = x'_{m-1}$; and when $n = 1$, $y_m = x_m$.

Hence $\sinh g's \cdot y_m = \sinh ng's \cdot x_m + \sinh (1 - n) g's \cdot x'_{m-1}$, (1)

where $g'^2 = \text{K}\,\nu\,(r' + l'\nu)$.

In A B (fig. 3) $u_o - v = (\rho + \lambda\, d/dt)\, x_m = (\rho + \lambda\,\nu)\, x_m$.

In A′ B′ $-u_o' + v = (\rho + \lambda\,\nu)\, x_m'$.

In M N $2\,v = (\rho' + \lambda'\nu)\,\xi$,

$\xi = x_m - x_m'$.

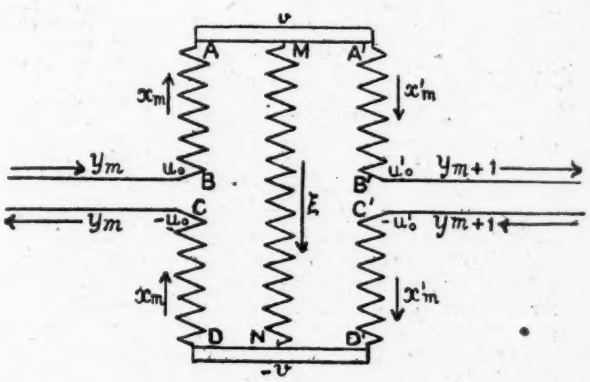


FIG. 3.

Eliminating v and ξ from these equations,

$$\left.\begin{aligned} u_o - u_o' &= (\rho + \lambda\,\nu)\,(x_m + x_m'), \\ u_o + u_o' &= (\rho + \lambda\,\nu + \rho' + \lambda'\nu)\,(x_m - x_m'). \end{aligned}\right\} \quad (2)$$

At every point of the twin line where $2\,u_m$ is the difference of potential between the wires,

$$-\,dy_m/dn = 2\,s\,\text{K}\,du_m/dt = 2\,\nu\,s\,\text{K}\,u_m,$$

$$\left.\begin{aligned} \text{Hence at B}\quad & 2\,\nu\,s\,\text{K}\,u_o + (dy_m/dn)_{n=1} = o, \\ \text{at B′}\quad & 2\,\nu\,s\,\text{K}\,u_o' + (dy_{m+1}/dn)_{n=o} = o. \end{aligned}\right\} \quad (3)$$

By differentiating (1)

$$\left.\begin{aligned} \sinh g's \cdot (dy_m/dn)_{n=1} &= g's\,(\cosh g's \cdot x_m - x'_{m-1}), \\ \sinh g's\,(dy_{m+1}/dn)_{n=o} &= g's\,(x_{m+1} - \cosh g's \cdot x_m'). \end{aligned}\right\} \quad (4)$$

Eliminating u_o, u_o', $(dy_m/dn)_{n=1}$, $(dy_{m+1}/dn)_{n=o}$ from (2) (3) (4),

we have

$$\left.\begin{aligned} x'_{m-1} + x_{m+1} &= \mathrm{P}\,(x_m + x_{m'}),\\ x'_{m-1} - x_{m+1} &= \mathrm{Q}\,(x_m - x_{m'}).\end{aligned}\right\} \qquad (5)$$

where $$\mathrm{P} = \cosh g's + \frac{2\sinh g's}{g'}\,\mathrm{K}\,\nu\,(\rho + \lambda\,\nu),$$

$$\mathrm{Q} - \mathrm{P} = \frac{2\sinh g's}{g'}\,\mathrm{K}\,\nu\,(\rho' + \lambda'\nu).$$

Equations (5) apply to the currents at all the inserted coils except that at the sending point (where $m = p$), at which point there is an impressed electromotive force so that equations (2) do not hold. At the receiving point o of fig. 2, the currents are equal on the two sides, so that $x_o = x_{o'}$, and $x_1 = x'_{-1}$, and the second equation of (5) disappears when $m = o$. We have then the following set of equations :

$$x_1 = \mathrm{P}\,x_o$$

$$\left.\begin{aligned} x_{o'} + x_2 &= \mathrm{P}\,(x_1 + x_{1'})\\ x_{o'} - x_2 &= \mathrm{Q}\,(x_1 - x_{1'})\end{aligned}\right.$$

$$\vdots$$

$$\left.\begin{aligned} x'_{m-1} + x_{m+1} &= \mathrm{P}\,(x_m + x_{m'})\\ x'_{m-1} - x_{m+1} &= \mathrm{Q}\,(x_m - x_{m'})\end{aligned}\right.$$

$$\vdots$$

$$\left.\begin{aligned} x'_{p-2} + x_p &= \mathrm{P}\,(x_{p-1} + x'_{p-1})\\ x'_{p-2} - x_p &= \mathrm{Q}\,(x_{p-1} - x'_{p-1}).\end{aligned}\right.$$

These equations are satisfied by

$$x_m = \mathrm{A}\cosh(m\,\theta + \phi)$$

$$x_{m'} = \mathrm{A}\cosh(m\,\theta - \phi)$$

where $$\cosh(\theta + \phi) = \mathrm{P}\cosh\phi$$

$$\sinh(\theta + \phi) = -\,\mathrm{Q}\sinh\phi$$

so that $$\cosh\theta = \frac{\mathrm{P\,Q} - 1}{\mathrm{Q} - \mathrm{P}}$$

$$\tanh^2\phi = \frac{\mathrm{P}^2 - 1}{\mathrm{Q}^2 - 1}$$

The known current at the sending end is $\mathrm{A}\cosh(p\,\theta + \phi)$, so that the values of A, θ, ϕ can be obtained, and hence expressions for all the currents in the system.

We have written $$\mathrm{G}^2 = \mathrm{K}\,\nu\,(\mathrm{R} + \mathrm{L}\cdot\nu)$$

$$g^2 = \mathrm{K}\,\nu\,(r + l\,\nu)$$

$$g'^2 = \mathrm{K}\,\nu\,(r' + l'\nu)$$

We will now write $$\gamma^2 = 4\,p\,\mathrm{K}\,\nu\,(\rho + \lambda\,\nu)$$

$$p\,\gamma'^2 = \mathrm{K}\,\nu\,(\rho' + \lambda'\,\nu)$$

so that $$\mathrm{P} = \cosh g's + \frac{\gamma^2 s}{2}\cdot\frac{\sinh g's}{g's}$$

$$\mathrm{Q} - \mathrm{P} = 2\,\gamma'^2\,\frac{\sinh g's}{g's}.$$

Section 6.—We are about to compare the expressions just obtained for a compound cable with those previously obtained for a uniform cable which is to have the same total resistance, capacity, inductance, and leakage. The total resistance and inductance of the compound cable are $r' + 4\,p\rho$, $l' + 4\,p\,\lambda$: and of the uniform cable R, L. We accordingly write $r' + 4\,p\,\rho = \mathrm{R}$, $l' + 4\,p\,\lambda = \mathrm{L}$. The total capacity is the same in both cases, viz., K; so that $g'^2 + \gamma^2 = \mathrm{G}^2$. The total resistance and inductance of the leakage of the compound cable are ρ'/p, λ'/p; and those of the uniform cable r, l. We accordingly write $\gamma'^2 = g^2$.

Expanding $\cosh g's$, $\sinh g's$, in powers of $g's$ in the expressions for P, Q − P, we have

$$\mathrm{P} = 1 + \frac{s^2}{\lfloor 2}\,\mathrm{G}^2 + \frac{s^4}{\lfloor 4}\,g'^2\,(\mathrm{G}^2 + \gamma^2) + \ldots.$$

$$+ \frac{s^{2n+2}}{\lfloor 2n+2}\cdot g'^{2n}\,(\mathrm{G}^2 + n\,\gamma^2) + \ldots.$$

$$\mathrm{Q} - \mathrm{P} = 2\,g^2\,(1 + \frac{s^2}{\lfloor 3}\,g'^2 + \frac{s^4}{\lfloor 5}\cdot g'^4 + \ldots.)$$

$$\cosh\theta = \frac{\mathrm{P\,Q} - 1}{\mathrm{Q} - \mathrm{P}} = \mathrm{P} + \frac{\mathrm{P}^2 - 1}{\mathrm{Q} - \mathrm{P}}$$

$$= 1 + \frac{s^2}{\lfloor 2}\,\mu^2 - \frac{s^4}{\lfloor 4}\,\{(\mathrm{G}^2/g^2 - \gamma^2)^2 + \gamma^4/g^2 - \mu^4\} + \frac{s^6}{\lfloor 6}\cdot\{\ldots$$

$$\theta = s\,\mu - \frac{s^3}{\lfloor 4\,\mu}\,\{(\mathrm{G}^2/g^2 - \gamma^2)^2 + \gamma^4/g^2\} + \frac{s^5}{\lfloor 6}\{\ldots$$

$$p\,\theta = \mu - \frac{s^2}{\lfloor 4\,\mu}\,\{(\mathrm{G}^2/g^2 - \gamma^2)^2 + \gamma^4/g^2\} + \frac{s^4}{\lfloor 6}\{\ldots$$

$$\tanh\phi = \left(\frac{\mathrm{P}^2 - 1}{\mathrm{Q}^2 - 1}\right)^{\frac{1}{2}} = \frac{\mathrm{G}^2}{2\,g^2}\cdot\frac{s}{\mu} + s^3\,\{\ldots$$

The ratio of the sent to the received current in the compound cable is

$$\frac{\cosh(p\,\theta + \phi)}{\cosh\phi} = \cosh p\,\theta + \tanh\phi\,.\,\sinh p\,\theta$$

$$= \cosh\mu + \left[\frac{s}{\lfloor 2}\,\frac{\mathrm{G}^2}{g^2} - \frac{s^3}{\lfloor 4}\,\left\{\left(\frac{\mathrm{G}^2}{g^2} + \gamma^2\right)^2 + \frac{\gamma^4}{g^2}\right\}\right]\frac{\sinh\mu}{\mu} + \text{terms involving higher powers of } s.$$

If s is small, so that the coils are numerous and closely-spaced, this tends to the value $\cosh\mu$, which is the value obtained in Section 2 for the ratio between the sent and received currents of the resultant uniform cable.

In the particular case where there is no leakage $g = \infty$, $\tanh\phi = 0$, and $\mu = \mathrm{G}$. The ratio of the sent to the received current is then $\cosh p\,\theta$, where

$$p\,\theta - \mathrm{G} = -\frac{s^2\,\gamma^4}{\lfloor 4\,\mathrm{G}} - \frac{s^4\,\gamma^4}{\lfloor 6}\,\mathrm{G}\left(\frac{5}{8}\cdot\frac{\gamma^4}{\mathrm{G}^4} - 2\,\frac{\gamma^2}{\mathrm{G}^2} - 2\right) + \ldots$$

If $\mathrm{G} = \alpha + \beta\iota$, and $p\,\theta - \mathrm{G} = a + b\,\iota$, the attenuation in the uniform line is approximately $\frac{1}{2}\,e^{\alpha}$, and in the compound line $\frac{1}{2}\,e^{a\,\pm\,a}$. The ratio of the attenuations of the two lines is then e^a, and if this is nearly equal to unity, the two lines will be closely equivalent for that harmonic. The condition that this shall be so, is that a is small, a being the real part of the last expression. Both the real and imaginary parts of γ/G are less than unity, so that if $s\,\gamma$ be a small quantity the other terms may be neglected compared with

$$-\frac{s^2\,\gamma^4}{\lfloor 4\,\mathrm{G}} + 2\,\frac{s^4\,\gamma^4}{\lfloor 6}\,\mathrm{G}$$

and, unless γ/G is also a small quantity, the second of these two terms may be neglected compared with the first. In cases then where the inserted coils are not insignificant in comparison with the rest of the line the condition that the compound and uniform lines shall be equivalent, is that both the real and the imaginary parts of the expression $\frac{s^2\,\gamma^4}{\lfloor 4\,\mathrm{G}}$ are small. For reference call this condition (a).

In view of the fact that in the uniform line $y_s/y_r = \cosh\mathrm{G}$, and that in the compound line

$$y_s/y_r = \cosh p\,\theta$$

$$= \cosh\mathrm{G}\,\left(1 - \frac{s^2\,\gamma^4}{\lfloor 4\,\mathrm{G}^2} + \ldots.\right)$$

it appears that the two lines may be treated as equivalent if $\frac{s^2\,\gamma^4}{\lfloor 4\,\mathrm{G}^2}$ and all terms in the last series involving higher powers of s may be neglected compared with unity. Call this condition (b).

Dr. Pupin points out that the following relation is sufficient for (b). The distance between any two consecutive coils is $s\,\pi$, and the wave length of the harmonic is $2\,\pi/\beta$, where as above $\mathrm{G} = \alpha + \beta\iota$. If the coils are close together compared with a half wave length $s\,\beta$ is small. Since α is $< \beta$, $s\,\alpha$ is also small. Consequently $s\,\mathrm{G}$ is small, and *a fortiori*, $s\,\gamma$ is small, and all the terms of the series

$$1 - \frac{s^2\,\gamma^4}{4\,\mathrm{G}^2} - \frac{s^4\,\gamma^4}{\lfloor 6}\left(\frac{5}{8}\cdot\frac{\gamma^4}{\mathrm{G}^4} - 2\,\frac{\gamma^2}{\mathrm{G}^2} - 2\right) + \ldots$$

are negligible compared with the first. Dr. Pupin's condition for the equivalence of the two lines is that the distance between the coils is to be short compared with the half wave length. Call this condition (c).

The degrees of approximation between the values of G and $p\,\theta$ given by conditions (b) and (c) are not the same as that between the values of the attenuations on the two lines, the

approximation between which is determined by condition (*a*). It is clear, however, that Dr. Pupin's (*c*), is not a necessary condition, since small local irregularities in an otherwise uniform line do not materially affect its transmission, though the distances between them may be much greater than the wave lengths.

Apply these conditions to the cases A1, A2, A3, of coils inserted in the telephone line used as an example in Section 4. In this case $s = 1/23$, and in the line without coils $\beta = 31$ for the higher harmonic considered; for the lower harmonic $\beta = \cdot 95$. Dr. Pupin's condition would indicate that none of the three cases can be calculated on the assumption of equivalence to a uniform line. Condition (*b*) would exclude the calculation of A3, but admits case A2 except for the upper part of the range of harmonics. Condition (*a*) admits A1, and excludes A2 and A3 altogether. The three conditions lead to different result, and (*a*) appears alone to be rigorous.

W. A. Price.

SOME EXPERIMENTS ON THE PROPAGATION OF HERTZIAN WAVES ALONG A WIRE, AND THROUGH THE AIR.

Telegraphy by means of a Simple Telephone as Receiver.

Cold Light.

By EMILE GUARINI.

(*Concluded from page* 86.)

Seventeenth Experiment. — For Hertzian currents to be applied to submarine telegraphy, they must be transformed to low tension. A tension higher than 20 volts would greatly add to the slightest fault in the gutta-percha covering of the cable. I have already stated that Hertzian currents can be transformed to any required tension and also to open primary and secondary circuits. The use of the rapidly alternating current like that in the secondary of a transformer, the primary of which is traversed by a rapidly oscillating current, and the use of the induction coil, would present the two following advantages, both very favourable to the increase of the speed of transmission :—

1. Very rapidly alternating currents are very favourable to the discharge of the cable.

2. Induced currents are propagated more rapidly than voltaic currents in the ratio of 3 to 1.

With the aid of a telegraph key, I was able to close the circuit of a battery of accumulators of eight elements, introduced into the primary of an induction coil in which a platinum interrupter rendered the current intermittent.

In the said circuit, owing to resistances introduced, a current of only 5 amperes was circulating. The coil gave as a maximum 4 cm. of spark between disc and point. The resistance of the primary of the coil was 11 ohms, and that of the secondary 8,000 ohms. The extremities of the secondary wire of the coil ended in an oscillator mounted on a stand apart from the coil. The oscillator consists of two little spheres about 3½ cm. in diameter, of nickelled copper, placed at the extremities of two rods, also made of nickelled copper, 1 centimetre in diameter, and terminated by insulating handles. These rods could slide in sleeves furnished with universal joints, the sockets of which were placed in terminals situated at the extremity of insulating columns, and connected with the secondary of the coil. The distance between the two balls was 1½ mm. One of the terminals was connected to earth by means of the gas pipe, and the other, being extended by a wire of about 50 cm., ended at a plane condenser with copper plates and a glass insulator 1 mm. thick. The condenser was 20 cm. wide, and 30 long. The other terminal of the condenser was connected with one of the terminals of the primary of a small transformer (1 ohm and 50 turns). The other terminal was free. One of the terminals of the secondary (200 ohms and 5,000 turns) was connected with one of the terminals of the secondary of an induction coil (11,000 ohms), which served to transform to low tension the current that was to pass through the artificial line. The other terminal of the secondary of the two transformers was free. The open circuit line commenced at one of the terminals of the primary (·25 ohm) of the second transformer, and consisted of resistance coils and condensers arranged in the following order :—

1. Coils of 1,000, 2,000, 4,000 ohms.
2. Condenser of ·2 microfarad.
3. Coils of 1,000, 2,000, 4,000, 1,000, 1,000, 2,000, 3,000, 4,000 ohms.
4. Resistance of 8,000 ohms constituted by the secondary of an induction coil of 4 cm. spark.
5. Condenser of about ·8 microfarad.
6. Coil of 1,000 ohms resistance.
7. Resistance of 11,000 ohms, consisting of the secondary of an induction coil with ·25 metre spark.
8. Condenser of ·2 microfarad.

It was to the other terminal of No. 8 condenser that one of the terminals of a telephone was attached. The other terminal of the telephone was free. I had thus constituted a line of a certain capacity and a certain resistance. It is true that the cable constitutes a continuous condenser, and the charge is spread out all along the length of the condenser instead of being localised at three determined points, as in the artificial line that I used. I did not use Mr. Muirhead's zig-zag condenser. But, on the other hand, the self-induction, and consequently the impedance, $\sqrt{R^2 + m^2 L^2}$ (R being the ohmic resistance of the conductor, L its coefficient of self-induction, and m the number of oscillations during the unit of time), were enormous in the artificial line, and in any case much greater than that obtained in cables. The tension in the artificial line was not higher than 20 volts.

Short and long signals transmitted to the manipulator were clearly and instantaneously heard at the telephone. I even suppressed the oscillator, the little spark at the interrupter of the bobbin was sufficient to allow short and long sounds to be heard very faintly at the telephone.

I was thus able to hear a dozen words a minute at the telephone. When I tried to increase the speed of transmission, I was no longer able to count the number of signals that I received, but could clearly distinguish dashes from dots. I transmitted very short signals. They arrived instantaneously at the telephone, where they were clearly heard. Experts accustomed to transmit and receive dispatches through sounders with a greater speed of transmission would certainly have been able to hear many more words a minute, probably about 50. The experiment may be improved :—

1. By diminishing the self-induction of the induction coil.

2. By using a very rapid interrupter working independently throughout the transmission of the dispatch, thus avoiding the starting of the platinum interrupter of the bobbin used.

3. By giving the second transformer a very low resistance, enabling its secondary to be attached directly to a ball of the oscillator, thus dispensing with an induction coil.

The object of introducing a condenser between the ball of the oscillator and the first transformer was to avoid sparks in the interior of the first coil.

As the experiment can be greatly improved, since the employment of rapidly alternating currents adapts itself very well to the charging and discharging of a submarine cable, and since the employment of the induced current enables the rate of transmission to be rendered three times as great as when the voltaic current is used (Whitehouse's experiment), it is probable that such a speed of transmission might be attained that the signals received through the telephone could not be followed by the ear. The arrangement that I propose to meet this contingency is the following :—At the transmitter the signals will be transmitted by perforated slips, as in the Wheatstone system, and at the receiver the vibrations of the telephone, of longer or shorter duration according to whether dashes or dots are transmitted, will be photographed by a process similar to that used in the Pollak and Virág system, by means of which, as is well known, a speed of 60,000 words per hour can be attained. This arrangement would also be applicable to wireless telegraphy with the aid of a single telephone as a receiver, if the system

gives at a great distance the same results as at a small distance. We must also add that with Hertzian waves it is possible easily to realise simultaneous multiplex communication.

With regard to this point we may recall the researches of Mr. Albert Turpain amongst others. I think it would be interesting to make some tests on cables. It would not be necessary to suspend the service to do so, as a dispatch by Hertzian waves can be transmitted (Mr. Slaby's experiment) even when the line is transmitting in duplex by the ordinary current.

Eighteenth Experiment.—By means of a manipulator I closed the circuit of a source of electrical energy of 2 amperes, introduced into the primary of an induction coil in which an interrupter rendered the current intermittent. The secondary of this coil was connected with the two terminals of an oscillator, the balls of which were about 4 mm. apart. One of the balls of this oscillator was connected to earth. The other was connected with a terminal of the primary of a little transformer. The two terminals of the secondary of this transformer were connected with the two terminals of the secondary of an induction coil. One of the terminals of the primary of this coil was connected with one of the terminals of the secondary of another induction coil. The two terminals of the primary of this last coil were connected with a telephone. This arrangement only differs from the preceding one in that the circuit of the telephone is closed at the two terminals of the primary of the last coil. The signals reproduced at the telephone were so powerful that even at a distance of 7 or 8 metres the powerful vibrations of the telephone could be heard perfectly, whereas in the preceding experiments it was necessary to place the telephone to the ear to catch the vibrations. I wished to establish a quantitative comparison in order to verify the energy received at the telephone. To do this I placed the telephone in circuit with a battery and a manipulator. Then only, when the current passing through the telephone was 200 milliamperes, the signals had an intensity equal to that which they had previously had with the Hertzian currents. The energy that arrived at the telephone, transmitted by a single wire, was, therefore, equal to 200 milliamperes, *i.e.*, one tenth of the energy employed (2 A).

If we take into account the fact that out of this energy of 2 amperes, a great part is absorbed by the interrupter (a loss that can be suppressed by using either an independent interrupter or an alternating current), another part is absorbed by the spark in the form of heat and light (a loss that can be lessened by various contrivances, especially by putting to earth one of the balls of the oscillator and by known relations of capacity, of self-induction and resistance in the circuit of discharge), if, above all, we take into account the losses in the four transformers, and, lastly, if we do not neglect the resistance of the line, we can legitimately conclude that Hertzian currents, transmitted by a single wire and without a return by the earth, must be subject to the same laws as the ordinary current.

Nineteenth Experiment.—I substituted for the telephone a little incandescence lamp. In this lamp a phosphorescence (cold light) was produced, similar to that obtained in the Tesla arrangement. This phosphorescence was also produced when the lamp was in a closed circuit with the primary as well as when it was only connected with it by a single terminal. On the other hand, it was absent when one of the terminals of the lamp was put in communication with the earth. (In this last experiment the communication between one of the balls of the oscillator and the earth was interrupted). It was necessary to have perfect contact in order to light the lamp. This is easily explained by the fact that the Hertzian current had been transformed to a low tension current by the two last transformers. It may therefore be concluded that cold light can be produced with Hertzian currents at low tension, transmitted to a given point (the lamp) through the medium of transformers on open circuit.

The Metric System.—The Russian Government has definitely decided to introduce the metric system of weights and measures into the Empire, and the Minister of Finance is considering how best to make the innovation.

CURRENT SPECIFICATIONS.

XLVI.—OLDHAM POWER STATION EXTENSIONS.

SUMMARY.

Extent of Contract.—Two 370-KW. and four 740-KW. steam dynamos. To be erected upon prepared foundations at the Greenhill power station.

Engine.—To be of the vertical, triple-expansion, three-crank enclosed type.

Specified Speed.—Not to exceed 300 revolutions per minute for the 370-KW. size, or 230 revolutions per minute for the 740-KW. size.

Specified Overload.—25 per cent. for short periods. When speaking of dynamos, the specification stipulates for a 25 per cent. increase in current for periods of one hour without undue heating or other defect.

Steam Pressure.—150 lbs. per square inch. Engines to work non-condensing at present, but to be suitable for working condensing hereafter if desired.

Specified Range of Governing.—When whole load suddenly thrown off, variation in steady speed not to exceed 3 per cent., and of momentary speed 10 per cent.

Specified Steam Consumption.—When tested non-condensing at most economical load not to exceed for either size of engine 21 *lbs. per electrical horse-power-hour.*

Capacity of Dynamos.—Each of the two smaller ones to develop as normal load 673 amperes at 550 volts. The sets to be compound-wound to permit of raising voltage from 500 volts at no load to 550 volts at full load. Two of the 740-KW. machines to be compound-wound to have a normal output of 1,345 amperes at 550 volts, the series winding being capable of raising the terminal voltage from 500 volts at no load to 550 volts at full load. Two of the 740-KW. machines to be shunt wound to have a normal output of 1,644 amperes at 450 volts.

Specified Combined Efficiency of Steam Dynamos.—Not to be less than 83 per cent.

Type of Transfer Switch.—Switch and lamp arrangements as specified to be provided to permit of the two larger compound-wound dynamos being worked *one at a time* as shunt-wound machines on the lighting system.

Permissible Temperature Rise.—Not to exceed 70° F. above atmosphere, measured thermometrically after six hours' full load run.

High Voltage Test.—To be tested for half an hour with all internal connections made and brushes down with 1,000 volts alternating currents.

Span Parts.—To be supplied as specified.

Specified Date of Delivery.—To be stated by tenderers in their offer. An earlier date to be given if possible for the two smaller sets.

Penalty for Late Delivery.—£20 per week.

Specified Terms of Payment.—85 per cent. on delivery, 10 per cent. when plant is taken over, and 5 per cent. at the end of 12 months.

Maintenance Period.—Twelve months from date of purchasers taking over plant.

Limit of Permissible Variation in Value of Contract.—10 per cent.

Stipulations as to Removal of Foreman and Workmen.—Satisfactory.

Stipulations as to Wages paid to Workmen.—Standard recognised rates of wages, or such wages as are generally accepted as fair in the trade, to be paid by the contractor.

Provisions as to Sureties.—Two sureties to be provided by contractor, or at option the retention money may be increased from 5 to 10 per cent.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—January 29th, 1901.

This specification has been issued by Messrs. Kennedy and Jenkin, the consulting electrical engineers to the Oldham Corporation. The extent of the contract is a pleasing testimony to the growing demand for electrical plant.

It seems only a year or two ago when sets of 100 KW. or 150 KW. were counted large units for such stations as this. The details of the switching arrangements by which only one of the large compound-wound dynamos can be connected to the lighting bus bars at one time, while both machines may be switched on to the traction bus bars, are of a novel and interesting character. The *25 per cent.* overload is to be calculated on the normal current generated at the standard voltage for the type of machine. Tests are to be carried out before delivery or at the station.

The technical part of this specification may be taken as nearly approximating to the model we trust one day will become the standard. The requirements are fully and clearly stated, but considerable latitude is allowed to the tenderer in the methods he adopts to fulfil these requirements. At the same time it will be evident to all that great care has been bestowed upon its preparation, and that only the highest quality of plant will be acceptable.

Dealing with the general conditions, we find that Clause 2

insists in a perfectly fair and justifiable way in the whole of the work being carried out in a thoroughly satisfactory manner.

The responsibility of the contractor is secured by Clause 6. This clause does not often appear in specifications, but in our opinion it serves a very useful purpose, as it invites the contractor to express an opinion upon any stipulation which he considers may be injurious to the satisfactory working of the completed plant. The clause reads :—

The contractor, by signing these presents and the relative drawings, specification and schedule of measurements (if any), shall be held to have carefully examined the same, and shall, in the absence of any previous written intimation by him to the contrary, be held to concur as a practical tradesman in the method and styles of construction to be adopted, and the sufficiency of the materials proposed to be used in the execution of the work.

The limitation, which we find in Clause 7, of the powers of the engineer to vary the work to be done under this contract to the equivalent of *ten per cent.* of the total contract sum, is a just precedent which we hope will be extensively followed. The usual practice of claiming unlimited powers in this direction is capable of great abuse.

Clause 18, referring to date of completion and penalty for delay, states :—

In the event of the contractor failing to complete the work within the term stated in his tender, or any extended period authorised by the engineer in writing, the contractor shall be liable and bound to pay to the Corporation as ascertained and liquidated damages, and not as penalty, the sum stated in the tender for each and every week that the work remains incomplete after the expiry of the said term, and the Corporation shall be entitled to deduct the amount so incurred from any money in their hands belonging to the contractor, *except in so far as such delays may be caused by fire or strikes of workmen.*

This last clause may well be copied into other specifications ; the spirit of fairness which it represents is too often conspicuous by its absence.

The contractor's guarantee of maintenance is expressed in Clause 24, which may, without reservation, be accepted by all tenderers.

It sometimes happens that would-be contractors find it somewhat difficult to arrange for the number of sureties which municipal authorities are in the habit of demanding. There is much to be said for the alternative method of providing a guarantee to the Corporation by agreeing to an increase in the amount of the money retained by the Corporation during the period of maintenance. This is permitted by Clause 33 of this specification.

The amount of surety is to be named by tenderer in his offer.

In the form of tender the contractor agrees to pay "in the execution of this contract, the standard recognised rate of wages, *or such wages as are generally accepted as fair in the trade.*" We do not anticipate that any firm of repute would have any difficulty in subscribing to this declaration.

Finally, the rights of both purchaser and contractor are safeguarded by an arbitration clause drawn up in a comprehensive manner. We wish that all specifications issued in connection with our industry were drawn up in a similar manner to this, which serves to a very large extent the best interests of both purchaser and contractor.

CHEAPER PRODUCTION AND FOREIGN COMPETITION.

In regard to the present position of English engineering, it is conceivable that the shriek of "Wolf!" to which we have now become so accustomed, may be heard so often that its constant repetition may nullify any good effects which calm and serious once-told truths might have. No words can be too strong for deprecating the "cheap" method of leading those who hold the foreign markets in their hands to believe that English engineering enterprise is a decade behindhand. We should have thought it was to the interests of all that what has been and what can be done by English works — yea, and what is being done even to-day, when we are thought by some to be practically out of the running — should be set forth in all its glory. Why not tell the world what we *can* do, instead of proclaiming upon the house-tops and in the presence of our foreign competitors the false news that we can't do this, we can't do that, we can't do the other? Fancy standing shivering, tail 'tween legs, in the presence of our foreign competitor with such a noble record to our account as is contained in the past history of English engineering!

A timely hint is right enough in its way and very welcome, but a perpetual shrieking of mangled untruths may make us look absurd in the eyes of the world, and defeat the professed object of the sensational stump oratory of the newsmonger who soothes us with the information that we are fast going to the dogs.

Far be it from us to suggest that the matter of our position in the engineering markets of the world be too lightly thought of ; we have ourselves already endeavoured to drive home the necessity for careful heart-searching, but we protest against the very gloomy view which is being given expression to by so many who do not know anything about the matter, but who love to wallow in the mire of ultra-pessimism. Foreign competition we have to meet, and meet it we shall. Looking at the matter from the point of view of electrical engineering alone, there are now several large manufactories in England which are equal to almost any emergency, able to fulfil any requirement. We may find it necessary to adopt some of the up-to-date pushfulness of our trans-Atlantic friends, but there are many ways in which we certainly shall not copy them. Congenial and successful those ways and methods may be in America, but would they answer here? We leave it for those who have tried and failed to answer the question. One point upon which we may perhaps take our cue from the States is in the adoption of more economical means of turning things from the raw product into the finished article.

Much has been said about the necessity for employing the most modern machinery and the most efficient and economical systems of operation. However far we may have gone during the past few years in recovering lost ground, there is still room for many engineering works throughout the country to seriously weigh this question of cheaper production, for if we can turn out work at lower rates, and yet of the same efficiency for which we are already famous, we shall, as an engineering nation, be still better equipped for commercial warfare. Mr. W. F. Goodrich, in a contribution to the current issue of the *Engineering Times* on "The Economic Aspect of Steam Generation," touches briefly on the subject. He states that there are "hundreds of manufacturers who will not seriously face the question of cheaper production," while successful competitors on the Continent and across the Atlantic attach enormous importance to it.

The British steam user "imbued with a dogged conservatism" looks upon many a new thing as being "altogether too scientific, too elaborate, most unnecessary and expensive." But does his foreign rival thus express himself? By no means, we are told. "He does not scorn the scientific, he is full of enterprise. If any innovation will tend to cheapen production, then he is interested." An instance of this sort of thing is cited by Mr. Goodrich. When looking into the sales of a certain instrument for recording any excess of air passing through the fires, he found that for every single instrument sold here, upwards of 40 were sold in Germany, Switzerland, and generally all over the Continent. Surely it is to the interests of the British manufacturer to employ every available means for keeping the fuel consumption at the lowest possible figure! Increasing attention to the matter of cheaper production must do English engineering an immense amount of good.

THE ELECTRICIFICATION OF MR. FORBES.

[COMMUNICATED.]

It is generally conceded that the relations of the Metropolitan and the Metropolitan District Railways are such that a harmonious working arrangement on most things is quite out of the question. Yet from the public point of view,

not to mention that of the shareholders, amicable co-operation between these bodies is highly desirable. Nor can we conceive any matter on which there ought to be serious differences of opinion; the two companies are hardly competitors, and they carry on, quite apart from each other, a large non-competitive traffic. The looping together of two portions of each company's lines, which results in the convenient, if disagreeable, inner circle railway, ought to give each concern advantages which it would not otherwise possess. It may be an anomalous state of things that the inner circle should be owned by two companies, but probably this would not be so obvious if the two railways had not led a cat and dog life. Bearing previous history in mind, it was generally supposed that the Joint Committee representing the two companies, which was appointed to go into the question of converting the lines for electrical working, would be unlikely to arrive at some common action, and the persistent rumours that serious differences had arisen among the members of the Committee, have culminated in the District Railway taking a distinct line of action. Whatever may be the outcome of the meeting of shareholders of the District Railway, it is clear that the proposals made by Mr. J. Staats Forbes have no reference to the northern portion of the Inner Circle. The question naturally arises as to whether the Metropolitan District Railway has power to carry out an electrical scheme on its own behalf. It is certain that as the Metropolitan Company is not mentioned in the chairman's speech, there is some lack of accordance between the two companies, and if we are correct in our view, the Legislature granted powers for applying electricity to the Underground Railway as a whole, and not as a part. Meanwhile, the officials of the Metropolitan Company make no sign, and one is only left to conjecture as to what will really happen.

The chairman of the District Railway contrived to infuse a remarkable degree of unanimity into the shareholders' proceedings. It is true they were left no option; the receipts have been steadily dropping since the inauguration of the Central London Railway, and it was the adoption of electricity as a possible remedy, or the gradual decline of the company's business, which the shareholders had to face. Moreover, the course adopted does not involve any immediate and personal sacrifice on the part of the shareholders. They had received no dividends for years, and under present conditions were not likely to receive any. On the contrary, the prospects of the District lines as dividend-paying concerns are much more promising under electric working than they were under the old primitive conditions. The unanimous vote of the District Company's meeting authorises the raising of £500,000 ordinary stock and £166,000 as a loan. It is extremely unlikely that the present shareholders will subscribe this amount, and after the experience of the Baker Street and Waterloo Railway the outside public are not likely to be much interested in the new issue. Where will the money be obtained? We should say without much hesitation that at least one contractor will subscribe largely for the new issue, and we are strengthened in this assertion when it is noted that Americans are commonly reported to be buying largely of the present stock. If a contractor takes up new stock on the understanding that he carries out the work it would simply resolve itself into a financial deal, and probably not a bad one, for there is little doubt that when the electrical equipment is nearly completed the value of the shares would be considerably enhanced, and at the psychological moment there would be a quiet unloading of them. There is very little to be said against such an arrangement; it is not new, and is moderately safe. In the case of the Great Northern and City Railway, the public did not take kindly to the venture, and the contractors came forward and took up the greater part of the issue.

There are rumours and counter rumours as to what system is likely to be adopted, and even one of our technical contemporaries has contrived to import a certain degree of mystery into the question by alluding in correct terms to the wonderful system suggested by Continental engineers. But the system is neither very wonderful nor very mysterious, and certainly is fairly widely known. It probably possesses many advantageous features, but notwithstanding the slight boom given to it by the daily press, we doubt whether it comes, at present, within the range of commercial engineering.

THE NERNST IMBROGLIO.

In our issue of December 28th we devoted a lengthy article, which we earnestly commend to the notice of the shareholders in the Nernst Company, to a critical consideration of the Nernst lamp, from both the commercial and the technical points of view, but we refrained from entering into the unfortunate dispute between Mr. Bernard Drake, the company's managing director, and Mr. Zusman, another director. A number of charges of a serious nature were brought by the latter gentleman against Mr. Drake at the meeting of the Nernst Electric Light, Limited, which was held on Wednesday, December 19th, and duly reported in our issue of the 21st ult. After a discussion, the meeting was adjourned for a month on the understanding that copies of Mr. Zusman's charges and Mr. Drake's replies should, in the meantime, be circulated among the shareholders.

We have had an opportunity of carefully and thoroughly examining the matters in dispute, and we hope that every shareholder has also done the same. For ourselves we have no hesitation in saying that the charges appear to us to be wholly without foundation, and Mr. Drake's replies effectually dispose of them; letters from Mr. Evered, Prof. Nernst, and members of the company's staff also completely refute several of Mr. Zusman's reckless charges.

The exigencies of space will not allow us to enter fully into this unfortunate dissension, but we may say that in his rejoinder to Mr. Drake's replies, Mr. Zusman gets still further out of his depth, and we think that any shareholder possessed of average intelligence will have no difficulty in coming to a like conclusion with ourselves.

What motive the author of these charges had in bringing them forward we fail to understand, when, on October 3rd, only seven weeks previously, he had written to Mr. Drake a letter, in which the following passage occurs:—"I have the highest possible opinion of your ability and energy, and could wish nothing better than that your powers should be entirely at the services of this company." If this does not dispose of the charges of mismanagement, neglect, want of tact, &c., then we wholly misjudge the acumen of the shareholders.

We have known Mr. Drake ever since he became associated with the electrical profession, and his career has been highly successful.

Were there but a modicum of truth in the extraordinary statements made by his fellow director, the firm of Drake and Gorham would scarcely occupy the position it holds to-day, nor would the Jandus Arc Lamp Company have paid a 40 per cent. dividend for the last three years.

We hope the chairman will assume a very decided attitude in dealing with this imbroglio at the company's meeting next week. Swapping horses when crossing a stream is not considered good policy, and a change of managing directors would be about as suicidal an idea.

The points in dispute should be put *seriatim* before the meeting, and there should be no difficulty in the shareholders coming unanimously to the conclusion that Mr. Zusman's charges are utterly unfounded, and have no existence in fact.

We foresee from this, in our opinion, unwarrantable attack, a possible difficulty affecting the electrical industry, inasmuch as men of position and technical ability will fight shy of joining the directorate of companies taking up new inventions if they are subject to such charges as these being made against them.

CORRESPONDENCE.

The Dangerous Third Rail.

In reply to "Cautious" in your current issue, it would be well if he could be led to accept the reported statement of the general manager of the "tremulous tube" which appeared in the *Daily Telegraph* of December 29th, and was brought to the writer's attention by a criticism on it in *Lightning*, January 3rd, 1901, signed "Engineer." The general manager is reported to have stated that he "frequently touches the third rail to see if it is alive, but

receives no shock." Is this a proof that the third rail is not dangerous?

The "Engineer" asked for a demonstration of the harmlessness of the third rail, and for an explanation of what it is that proves the rail to be charged if it gives no shock.

If "Cautious" will oblige us with accurate details of the "several fatal and many serious accidents which have occurred on the New York City Overhead Electric Railway," it will be advantageous. Vague statements like this are easily made, but when brought down to accuracy, the "many" may be found to be few.

To what overhead electric railway does he refer?—no overhead railway was running in New York City by electricity when the writer left there six weeks ago.

We have not heard of any "electrical deaths" on London electric railways, and the writer is particularly anxious to obtain complete and accurate details of all such deaths.

A Medical Man.

January 12*th*, 1901.

Electric Governors.

Could any of your readers give me any information with regard to electric governors for engines driving dynamos? I believe there is a very simple and effective one invented by a Mr. Thunderbolt, a description of which appeared in some electrical paper in 1897.

I shall esteem it a great favour if any reader who has had any experience of electrical governors will put himself into communication with me, or answer me through your columns.

George Ward, A.M.I.E.E.

St. Petersburg,
January 11*th*, 1901.

[The Thunderbolt governor was described in the Electrical Review for October 29th, 1897, page 571.—Eds. Elec. Rev.]

A Two-Phase Problem.

It may be of interest to Mr. Russell and others among your readers, to know that the tests, to which I referred in your issue of the 4th inst., were carried out at a central station not a hundred miles from City Road.

As two-phase plants are now coming into use in this country, it would be interesting to know whether any other similar tests have been carried out by this method, it being possible, as Mr. Russell has shown, for the apparent output of the machine to be 20 to 30 per cent. in excess of the true output.

Seloc.

LEGAL.

Lane *v.* Elliott Bros.

The case of Lane *v.* Elliott Bros. came before Mr. Justice Ridley in the Queen's Bench Division on Friday last, on an interpleader issue. The plaintiff, Mr. Reuben Lane, a chartered accountant, of Birmingham, sued as receiver of the New Fowler-Lancaster, Limited, a Birmingham company, to recover £269, which was due from the Mayor and Corporation of Brighton for certain electrical work performed for them under contract. Defendants, a firm of electrical engineers, carried out the work of the Birmingham company, and they had obtained from Mr. Justice Buckley a guarantee order for the balance of account due from the Brighton Corporation. The issue sent to the Court for trial was whether the plaintiff, as receiver for the debenture holders of the New Fowler-Lancaster, Limited, was entitled to the money, or whether the defendant firm, who had carried out the electrical work, had prior claim.

Mr. McIntyre and Mr. Turner appeared for the plaintiff, and Mr. Lochins represented the defendants.

Mr. Turner said the original company was incorporated in Birmingham in 1894, under the style of the Fowler-Lancaster Company, Limited. It was reconstructed in 1897 under the name of New Fowler-Lancaster, Limited, and in August of that year debentures to the amount of £12,000 were issued by the new company. In January, 1898, the name of the company was further altered by dropping the word New, and that was approved by an extraordinary general meeting of shareholders in February, and formally confirmed at another meeting in March. Although the alteration in name was duly registered at Somerset House, the secretary omitted to apply for the sanction of the Board of Trade, and that being necessary under the Companies' Acts, the new name, that of Fowler-Lancaster, Limited, was not a legal name. However, the company continued to carry on its business under the amended title, and among other contracts they entered into that with the Brighton Corporation. The contract was dated August 11th, 1899. On these facts the learned counsel argued that there being no such company as Fowler-Lancaster, Limited, the contract, though purporting to be entered into with the company, was really entered into with the New Fowler-Lancaster, Limited, which was the only company legally in existence at the time. In that case the debenture holders of that company had a prior claim to the property of the company, and plaintiff, as receiver on their behalf, was entitled to judgment.

Mr. Walter Hands, the secretary of the company, or companies, gave evidence. In cross-examination, he said £12,000 debentures were issued, one half of which were held by Mr. Fowler and Mr. Lancaster, two of the directors of the reconstructed company, and the remainder by the bank. At the time of the reconstruction he did not know that application to the Board of Trade was necessary. It was true that the defendants had done this electrical work at Brighton.

Mr. Lochins: Why, then, did you not pay them?—Because we had not got the money to pay with.

After some other evidence,

Mr. Lochins, for the defendants, characterised the whole proceedings on the part of the company as a juggle. The defendants had carried out this work for a body of persons calling themselves Fowler-Lancaster, Limited, which had no debenture holders, and now it was sought under some convenient family hocus-pocus to deprive his clients of payment for the work done under the pretence that the company was all the time the New Fowler-Lancaster, Limited, whose debentures were held by the directors and their bank. He argued that his clients were entitled to judgment, the name under which the company entered into the contract being misleading.

Mr. Justice Ridley reserved judgment.

B.T.H. Co. *v.* Bristol Tramways Company.

In the Court of Appeal on Friday, January 11th, the case of the British Thomson-Houston Company *v.* the Bristol Tramways and Carriage Company, came before the Master of the Rolls, Lord Justice Collins, and Lord Justice Stirling.

Mr. Banks said he appeared for the defendant company, who appealed from an order of Mr. Justice Day who had appointed a barrister as umpire in a dispute between the two parties. Defendants desired that an engineer should act as umpire. Plaintiffs had undertaken the work of electrical construction for the defendants for a sum of £114,000. This was to be paid in monthly instalments on the issue of a certificate by the defendants' engineer at the central station. A dispute arose as to the proportionate amount to be paid to the contractors, and accordingly they exercised their right to go to arbitration. Each party appointed an engineer as arbitrator, and they in turn suggested the appointment of an umpire. Plaintiffs submitted the name of Prof. Kennedy. But the defendants could not consent to the appointment of the eminent engineer, because he had been concerned in the matter. Thereupon the plaintiffs said they would have a barrister as umpire. Mr. Justice Day had made an order appointing a barrister.

The Master of the Rolls said that this was not a case in which the Court felt disposed to interfere with the learned judge's decision. The applications must therefore be dismissed with costs.

Wolverhampton Corporation *v.* The British Electric Traction Company.

A motion in this action came before Mr. Justice Farwell in the Chancery Division of the High Courts on Friday last. The motion asked for an order of the Court to enforce a judgment given in favour of the plaintiffs by Mr. Justice Joyce last sittings in an action for specific performance of a contract, contained in an Act of Parliament, by which the defendants were to sell their whole undertaking to the plaintiffs. Notwithstanding that statutory contract, the plaintiffs had been obliged to sue. Judgment was pronounced in their favour on November 29th last, and the purchase price was fixed at £4,259. Plaintiffs desired possession and tendered that sum to the defendants.

His Lordship made the order asked for, giving possession of the undertaking to the plaintiffs on payment of the purchase money, the defendants being ordered to pay the costs of this motion.

THE MANUFACTURE OF FERRO-TITANIUM AT NIAGARA.

By O. E. DUNLAP.

Ever since the Niagara Falls power development has been in operation the tendency of the processes successfully operated there has been to revolutionise various fields of manufacture. The fact that a wonderful amount of electric current is available at Niagara

has made it possible for inventors of processes requiring great heat to secure it, and the electric furnaces of the Niagara region are not equalled in the world. More than one market has been affected by the output of the plants at the Falls, and now comes news of another establishment there, the output of which is destined to be felt in its wonderful influence on a market which is said to be the pulse of the industries of the country. This is the iron and steel market, and it is already intimated that a success won in an experimental station on the lands of the Niagara Falls Power Company will make possible the use of great iron ore deposits heretofore thought to be quite unfit for use.

So great has been the demand for iron ore of late years that a famine in this market has been predicted. It is estimated that of the iron ore available in the United States at least 30 per cent. is unfitted for use because it is what is known as titaniferous iron. It contains a percentage of titanium. In a small, old stone dwelling on the property of the Niagara Falls Power Company, Augustus J. Rossi has been experimenting with this ore, and has found a process by which it is effectively made suitable for all kinds of use where iron is called for. This means that the enormous deposits of this class of ore, heretofore thought unavailable, will now be brought into consumption. In the State of New York there are mountainous deposits of this class of ore, and in the Adirondack region alone there is said to be a deposit that would last the world a century or longer. A feature of these deposits is their nearness to the markets, and the ease and cheapness with which they can be mined and handled. Michigan, North Carolina, and Colorado, as well as other States, are rich in this new-found wealth, if such it may be called. A remarkable fact, quite well worth pointing out, is the fact that these deposits have been placed by nature near the surface, where they are easily reached. It was John Birkenbine, of Philadelphia, who, in a paper presented to a recent meeting of the American Society of Mining Engineers, treated this fact with regret, sorrowfully stating that nature seemed to have placed these apparently worthless deposits within easy reach. It is therefore apparent that if this iron ore containing titanium can be easily smelted, the country's wealth will make material advancement, and that several States will profit largely and quickly.

At the same time that the above mentioned experiments have been conducted search has been made in a no less important field for results, whereby the quality of steel might be increased and its production cheapened. Success has also crowned these efforts, the result being the discovery of a method to produce ferro-titanium, an alloy which, if all the statements concerning it are maintained, is destined to win the favour of the world. Up to the present time it has been thought that iron ore containing titanium could not be worked, as the titanic acid produced developed an infusible slag. The Niagara Falls experiments prove this conclusion to have been accepted without full investigation, or at least without the resources which now make the use of this ore possible under Mr. Rossi's method.

It is given out that Mr. Rossi's plan is to treat the titanic acid as in other furnaces silica is treated. To make a slag no silica is added, but the result is accomplished by the addition of a dolomitic limestone. It is apparent that the greater number of bases, the larger the number of substances that unite with silica, the more fusible the slag. Therefore a magnesium limestone is added to bring about this condition, and the only silica used is what is brought into the furnace in combination with other substances.

It is a quite well known fact that the supply of hard ores in the United States is limited. It is for this reason that the custom has been to mix the hard ores with hematite ores to obtain what is pronounced the best iron. The public is more or less acquainted with the fact that the ores of Lake Superior are very popular, and the same may be said of the Messaba ores. Still, the supply of these ores is of such extent that they may be called abundant. To-day, ores containing in the vicinity of 30 or 35 per cent of iron are transported from Lake Superior to Pennsylvania to meet the market requirements. If it were not for the fact that transportation by water is cheap, this would not be possible under the present market conditions. The titaniferous ores of New York, Michigan, North Carolina, are known as "fat" ores. In the Adirondacks ores containing 54 to 64 per cent. of iron are found, and these contain from 10 to 18 per cent. of titanium, being free from phosphorus and sulphur. It is evident that if these "fat" ores of the Adirondacks can be worked they will prove extremely valuable.

To-day about 500 lbs. of the new alloy, ferro-titanium, are turned out every 24 hours at Niagara; it has been given around to steel manufacturers for experiment, and these experiments have created a demand. Early last autumn a meeting of the men interested was to be held to take steps to erect a large manufacturing plant at the Falls; the force of this company will be recognised when the names of such men as J. J. Albright, Edmund Hayes, Gen. Field, of Buffalo, C. S. Maurice, of Athens, Pa., and James McNaughton, of New York, are connected with it. Mr. Albright is the chief stockholder in the mammoth steel plant that is being erected at Stony Point, near Buffalo, and it will not be surprising if it turn out that the conception of that great plant was found in the experiments that have been made with such success at Niagara Falls. So great an iron king as Andrew Carnegie is quoted as having said that the best thing that could be done with the old iron foundries at Troy, N.Y., was to destroy them with an explosive, but under this new process of treating iron ore the Hudson Valley should become a greater industrial spot than is to be found in and about Pittsburgh. The popularity of ferro-titanium will be found in the result it brings, as well as in the fact that it will be cheap. There are numerous ferro-metals, all of which give some particular result, but they are all costly. While the experiments have been conducted quietly, the fame of the product has gone abroad, and it is known that one foreign government has secured enough of the ferro-titanium to make an armour-plate test. Considering the importance of the claims made for ferro-titanium, it is not strange that the inventor of the process declines to give out figures showing just how much steel is benefitted by its use. In fact, the success of one manufacturer may be greater than that of another, even when adopting similar practices. There has always been more or less of a mystery about steel making, and the question has always been why ores of seemingly the same composition manufactured into steel in a graphite crucible should prove better than the same ore made into steel in the converter or the open-hearth process. Of the three materials, the converter steel will be the poorest, the open-hearth better, and the crucible steel the best of all. The opinion has been expressed by eminent authorities that the difference is no doubt due to the presence of hydrogen and nitrogen in the steel. It has been Mr. Rossi's experience that ferro-titanium has an affinity for nitrogen, and therefore has a tendency to remove it and purify it. This result supports the conclusions of the scientists referred to.

The claim is made that the introduction of ferro-titanium in cast-iron will increase its cross-breaking powers from 25 to 50 per cent., and its tensile strength the same amount. Thus for castings made to stand high pressure, such as steam pipes for boilers, and similar uses, the use of ferro-titanium will be found very valuable. Tests are now being made in a well-known steel works in this country (U.S.A.) of its value as applied to crucible steel. It is known that its presence imparts tenacity and elasticity to a high carbon or hard steel.

Niagara Falls is naturally rejoicing over the success of the experiments, because it no doubt means the location there of another wonderful industry, for the intense heat given by the electric current is what is needed to manufacture ferro-titanium successfully. Through large furnaces containing scrap iron, titaniferous ore and small blocks of aluminium, the powerful current of the Niagara dynamos is sent. A glow comes from the mass; the aluminium begins to burn and the heat given off by it adds to the temperature. The result of the reduction is pure oxide of aluminium, ferro-titanium, a mixture of iron and titanium, and a slag that is valuable. The ferro-titanium is put up in cake form, and is now obtainable by any steel manufacturer who desires to make experiments. The present product comes from four small furnaces, but at the meeting to be held soon, steps to erect a big factory will be taken.

Canada is also rich in titaniferous ores, and the prospective power development on the Canadian side at Niagara will place that section in line to be largely benefitted by the result of Mr. Rossi's experiments, for from that side of the river the British market might be supplied.

WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE.

Mr. Thwaite's second article in the *Engineering Magazine* on water-tube boilers is descriptive rather than critical. He divides water-tube boilers into two main classes, namely, those with large tubes and those with small tubes, and a number of both classes has been selected by the author for description. Naturally the Belleville boiler comes in for a first description, and receives very lenient handling. Indeed, every credit is given to its inventor, and a note is given to the effect that the French cruiser *Guicken* actually made a voyage from Brest to Saigon at an average speed of 16 knots, whereas, in the British Navy the vessels with Belleville boilers have almost invariably come to grief. The author asks what the experiences of the Bellville boiler in other navies have been. Large numbers are used. He likewise seems to think that the chief trouble has arisen from leakage *viâ* the condenser tubes, and appears hopeful that the result may be an improved form of condenser construction. The author thinks the failures have arisen through the use of welded instead of solid tubes, but he cannot or does not say if other navies have or have not used one or the other class of tubes, though we believe the French ship *Friant* had welded tubes, and that one of these tubes burst with disastrous results.

In our opinion, welded tubes are unsafe for the work, but, welded or solid, neither variety can correct the bad principles on which the boiler is founded, the flat inclination of the tubes, their enormous length and many sudden bends, their total unfittedness for circulation, and the inevitable smoke they produce, together with the terrific complication of parts and accessories designed to remedy the defects of an inherently bad design.

The defects considered salient by Mr. Thwaite are the welded tubes, bad support of tubes, and want of freedom of end boxes to expand, the broken line of circulation, the imperfect front connection, and the angle of inclination. He also cites the elaboration of

deposit collectors to prove that the circulation cannot be relied upon to scour the interior clean, the bad fitting of smoke and fire doors, and the delicate accessory machinery, and doubts the general suitability of the boiler for shipwork. This, we think, is letting down the Belleville boiler as lightly as possible, but the fact is emphasised by an elevation of the boiler showing the feed heater or economiser perched up very much aloft at the base of the funnel and proving the poor efficiency of the boiler as a heat absorber. Indeed, the presence of a secondary combustion chamber between the boiler proper and the economiser is proof either of further folly of design or that the gases come so very hot through the boiler that, with an admission of more air, they actually burn again in this further chamber. Finally, Mr. Thwaite condemns the insufficiency of the arrangements for combustion, and considers the boiler totally unfit for any degree of forcing.

In the Niclausse concentric tube design the chief defect appears to be the sudden turn of the water from the inside to the outside tubes, otherwise the author looks on this boiler favourably, as regards removal of tubes, provision for free expansion and the limited loss of water should a tube fail—the loss being limited to one element only. The French torpedo boat *Téméraire* was tested and burned no less than 84 lbs. of coal per square foot of grate per hour, and not a tube was in any way deformed. It is also stated that unaccustomed firemen can keep steam with the Niclausse boiler, and it is well known that specially trained men must be employed with the Belleville—a point of the greatest importance.

There is greater space above the fire for combustion, and smoke should be reduced thereby. In some experiments made by Niclausse, he found that the first or lowest row evaporated 25 per cent. of the whole, the first three rows evaporated 50 per cent., the first six rows 66 per cent., while the remaining six rows did the remainder, the top row doing 3¾ per cent. The author suggests that the height of the combustion chamber might still be increased with advantage and a supply of air given above the fire, an automatic feed might be applied, and the malleable iron parts might be of mild steel with advantage.

The Dürr boiler—a German boiler on the same principle as the Niclausse—is also described. It does not differ much, except in the collectors, which are in the form of a flat chamber with central diaphragm.

The Babcock & Wilcox marine boiler is very different from their land boiler—short, with one steam tube and a superposed economiser. The boiler tubes are inclined at an angle of 1 in 4, and the tubes are expanded into the headers—a disadvantage when it comes to removal. The *Marietta*, a U.S. vessel, made a trip of 11,000 miles at 13 knots, from San Francisco to Key West, with the B. and W. boiler. The boilers measured 11 feet 6 inches × 9 feet 6 inches × 11 feet, with a grate surface of 95 feet, 57 tubes 7 feet 6 inches × 4 inches, and a heating surface of 1,810 feet.

In the small tube class, credit is given to Du Temple as the originator, to Thorneycroft as the improver of this class. The Du Temple boiler had tubes too squarely bent for good circulation, and this defect was remedied by Thorneycroft, who also introduced the practice of ending the tubes over the water line so as to compel a one-way circulation. In these small tube boilers and others, the fire and combustion space is between the sloping rows of tubes. In the Weir boiler, and some others, this is lined with brick to assist perfect combustion—a point not referred to by the author, but one of great moment where bituminous fuel is used.

Thorneycroft tubes are only 1¼ inches outside diameter, and but 0·128 in. thick, and even 1½ and 0·104 are dimensions employed in some boilers. Needless to say, the admission of salt water is not desirable. It tends to priming. The disadvantage of this and some other small tube boilers is the large number of different patterns of tubes in one boiler. This necessitates so many sizes being carried in stock for repairs. This point has been allowed so much weight by Farron that he makes his tubes all of equal length and straight, and he also drowns all the tubes. Normand combines the foregoing two types in one boiler. A useful table is added by Mr. Thwaite, giving a few leading figures for comparison of eight boilers from the shell type to the large and small water-tube varieties.

COAL FROM INDIA.

THE coal question is receiving much attention at the present time, and it is well that it should be so, as the one thing that England has to fear is the time when the excess of coal raised over that required for home consumption begins permanently to decrease. At the same time, the fact that the British Empire is one upon which the sun never sets leads to a consideration of the part our Colonies could play in time of need of coal. The possibilities of India appear to have been overlooked.

The following table gives the amount of coal imported and exported by the more important coal-producing countries in 1898.

	Imports.	Exports.	Excess of exports.
United Kingdom ...	11,000	48,268,000	48,257,000
Germany	5,820,000	13,989,000	8,169,000
Belgium	2,758,000	6,497,000	3,739,000
United States ...	1,317,000	4,226,000	2,909,000
Japan (1897) ...	69,000	2,103,000	2,034,000
New South Wales ...	1,000	2,792,000	2,791,000
Natal	...	126,000	126,000

And from the following table the excess of coal imported in certain countries will be seen:—

	Imports.	Exports.	Excess of imports.
Russia	2,981,000	52,000	2,929,000
Sweden	2,458,000	...	2,458,000
France	11,713,000	2,618,000	9,095,000
Spain	1,441,000	3,000	1,438,000
Italy	4,432,000	18,000	4,414,000
Austro-Hungary ...	6,004,000	1,019,000	4,985,000
Canada	3,246,000	1,056,000	2,190,000
Victoria	562,000	...	562,000
South Australia ...	412,000	38,000	374,000
Western Australia ...	132,000	26,000	106,000
Queensland	23,000	4,000	19,000
Tasmania	35,000	3,000	32,000
New Zealand ...	115,000	65,000	50,000
Cape Colony ...	301,000	128,000	173,000
British India ...	379,000	327,000	52,000

From these figures it will be seen that Great Britain still supplies a large proportion of the markets of the world, and that she is practically the only country in which the amount of coal imported bears an insignificant proportion to the coal exported.

Our Colonies, with the exception of New South Wales and Natal, all import more than they export.

Statistics for 1898 show the average cost of production in the various countries to be as follows:—

	s.	d.	
United States...	4	5	per ton.
Great Britain	6	4½	„
Germany	7	4½	„
Belgium	8	9½	„
France	9	0	„

In Bengal, however, the average price does not exceed 4s. 10d. and sinks as low as 2s. 8d.

It is physically impossible for the amount of coal exported from America to reach such dimensions as will disturb the world's trade within the next few years, but that, of course, is no guarantee of the indefinite postponement of a considerable export trade from the United States.

In the meantime every encouragement should be given to our Colonies to produce coal, and so reduce the extent of their dependence upon outside sources for so essential a commodity as coal. This is a matter of national importance, and should be seriously taken in hand by our Government.

REVIEWS.

Technical, Industrial and Commercial Vocabulary. By E. HOSPITALIER. Paris: *L'Industrie Electrique.* 1900.

The want of a handy, reliable, and comprehensive polyglot technical dictionary, is one that has long borne heavily upon all those within whose province it falls to con the pages of books and journals printed in foreign languages; it is with pleasure, therefore, that we welcome M. Hospitalier's new vocabulary of English, French, and German words. It is not altogether new, as a matter of fact, for it was issued in parts with the numbers of our esteemed contemporary last spring, with a view to smoothing the path of visitors to the late Exhibition; the work is now reissued in the form of a bound volume, with the advantage of having received a large number of corrections and additions through its preliminary issue.

Having had the better part of a year's personal experience of its use, we are able to say that it is a work entirely to our liking, and that it has been most useful to us. The arrangement of the vocabulary is, to the best of our knowledge, quite novel; it is most readily explained by an example, which we give below:—

Factory. ATELIER. Werkstatt.
Facture. *Bill.* Faktura. Rechnung.
Faden. FILAM—(ENT. *ent.*). ‖ BRIN. *Thread.*

It will be seen that each word, of whatever language, is printed in bold-faced type in the first column in alphabetical order; its equivalents in the two remaining languages follow, French words being printed in small capitals, English in italics, and German in Roman type. Where the root of a word is common to two or more languages, the variable endings alone are given, as shown. Each of the equivalents will generally be found elsewhere in the vocabulary, in its alphabetical position.

We have found this arrangement very convenient, and have seldom failed to find the word required; the revised and enlarged edition will no doubt prove still more satisfactory, and we strongly recommend it to our readers. We

may add that the editor offers a copy of the next edition to each of his readers who sends him at least 200 useful corrections or additions.

Lockwood's Builder's and Contractor's Price Book for 1901. Edited by F. T. W. MILLER. London: Crosby Lockwood & Son.

This book contains a great amount of information regarding the latest prices of every kind of material and labour connected with building, and as a matter of course there is an electrical section, since it is becoming the rule in electricity supply areas for new buildings to be wired as they are erected. The growing use of interior conduit wiring systems has led the editor to include particulars thereof in the present issue. Some tables of prices of electric generators, motors, transformers, lamps, lighting fittings, and cables and wires, presumably taken from the catalogues of a number of leading English manufacturers or suppliers, may be of some service for preparing *rough* estimates. There are a few notes on the cost of wiring houses, and the electric lighting rules of the City of London Electric Lighting Company are reprinted. The information given is quite as ample as one could expect in a publication of the kind, which must necessarily cover so vast a ground, in which electric lighting is but a small item.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JAN. 16TH, 1900.		WEEK ENDING JAN. 15TH, 1901.	
Alexandria	Value £147	Auckland	Value £232
Amsterdam	55	Bombay	511
Auckland	30	Calais	30
Barcelona	70	Calcutta	355
Bombay	144	Cape Town	442
Buenos Ayres	82	,, Teleg. mat.	226
Calcutta	3,023	Colombo	73
,, Teleg. manufactures	156	Copenhagen. Teleg. wire.	405
Cape Town	778	Durban	630
Christchurch	45	,, Teleg. mat.	127
Christiania. Teleg. wire	117	East London	109
Colombo	523	Gibraltar	589
Copenhagen	105	,, Teleg. cable	13,080
East London	54	Gothenburg. Teleg. wire	28
Flushing	13	Kure. Teleg. cable.	1,514
Gothenburg	57	Lisbon. Teleg. cable	9,720
Hong Kong	31	Madeira. Teleg. cable	490,000
Melbourne	202	,, Teleg. mat.	305
,, Teleg. wire	306	Malaga	120
Montreal	88	Melbourne. Teleg. wire	475
Napier	28	Monte Video. Teleg. mat.	150
Ostend	38	N. Atlantic. Teleg. cable	84,700
Port Elizabeth	82	Rio Janeiro	13
St. John's (N.F.) E. detonators	25	St. Vincent. Teleg. mat.	2,503
St. Petersburg. Teleg. mat.	1,443	Santos	490
Shanghai	630	,, Teleg. mat.	320
Singapore	80	Shanghai. Old teleg. wire	100
Stockholm	38	Sydney	796
Sydney	127	,, Teleg. mat.	125
Yokohama	269	Yokohama	119
Total	£8,786	Total	£558,087

Foreign Goods Transhipped.

Brisbane. Teleg. mat.	Value £96	Genoa. Electl. goods.	Value £118
		Perth. Electl. goods.	473
		Total	£591

Annual Dinner.—The fourth annual dinner of the staff of the North Staffordshire Railway Electrical Department was held last week, about 60 being present. Mr. J. Neale, M.I.E.E., the company's electrical engineer, presided. After dinner a capital musical programme was provided by members of the staff.

Auction Sale.—Mr. G. N. Dixon is on 22nd inst. to sell by auction, at 75, Kitchen Street, Liverpool, the working plant and stock of an electrical engineer (Queen's Dock Electric Works, Limited,) by order of the liquidator. For further particulars apply to Mr. B. Simmons (liquidator) 26, North John Street, or to Mr. Dixon, at 89, Hanover Street, Liverpool.

Automobile Driving.—At the City of London Summons Court on Friday last Walter Charles Bersey, of North Street, Manchester Square, was summoned for, on December 29th, causing a light locomotive to be used without having a competent person in charge. Mr. Staplee Firth, solicitor, appeared for the defendant. The Alderman fined defendant 20s. and costs, but a stay of execution was granted pending appeal.

Books Received.—"Fire Tests with Fire-Resisting Curtains and Blinds" and "Fire Tests with Floors." London: 1900. The British Fire Prevention Committee. 2s. 6d. each.

"Practical Electro-Chemistry," by Bertram Blount. Westminster: Archibald Constable & Co., Limited. 15s. net.

"Dynamo-Electric Machinery." By Samuel Sheldon and Hobart Mason. London: Crosby Lockwood & Sons. 1901.

"Fortschritte der Elektrotechnik." By Dr. Karl Strecker. Berlin: Julius Springer. 1901.

Catalogues, Lists, and Calendars.—A number of circulars illustrating some new types of horizontal and other engines recently brought out by Messrs. Marshall, Sons & Co., Limited, of Gainsborough, are before us, also the firm's latest catalogue (industrial section) of steam engines, boilers, and other machinery. These publications are all very well laid out and illustrated, and, we have no doubt, are kept on file for reference by users and purchasers of such machinery all the world over. Another list (No. 208) gives particulars of some of the principal electric light installations driven by Marshall's engines and boilers. The list is a long one, and includes many important plants A few details and pictures are given of the type of engine employed.

Messrs. R. W. Blackwell & Co., Limited, not long ago sent us copies of the revised edition of the lists of the Christensen Engineering Company, of Milwaukee, whose brakes have been frequently mentioned in the columns of the ELECTRICAL REVIEW. The list devoted to air compressors, hoists, and jacks shows and describes the motor compressor, automatic governor, and other apparatus. A diagram of the connections, both for the air and the electric part of the apparatus, is given, and there are tables showing the power and capacities, the dimensions and weights of Christensen compressors; another table gives the weights and capacities of air hoists and air jacks. The straight air-brake apparatus list discusses the desirability of straight-over automatic air for ordinary electric service, and shows diagrammatically the application of the straight air-brake system to motor cars and trailers. The illustrations are of the first order, and they are very plentiful, both photographic and sectional views. Instructions are given in some detail for maintaining and operating the Christensen air brake with independent motor compressor. A third list, got up in the same excellent style as the others, describes the Christensen system of air brakes with axle-driven compressor, and contains also directions for equipment and instructions for motormen and caretakers.

A collection of catalogues from Messrs. R. Hornsby & Sons, Limited, brings to our notice their various agricultural machinery, boilers, and implements. The Hornsby-Akroyd oil engine is dealt with in a separate list, which tells one the full general details of the working of the engine, gives instructions for erection and so forth, explains its purposes, and includes the results obtained in tests made by Prof. W. Robinson, of Nottingham. A number of testimonials are printed, and these include some users of the engine for electric lighting and tool driving purposes. The Hornsby "safety" water-tube boiler is illustrated and particularised, and the general principle is shown by large sectional drawings in colours.

A substantially-prepared catalogue of steam engines for a variety of purposes comes to hand from Messrs. Robey & Co., whose name among engine-users everywhere is more or less a household word. The illustrations, which are well executed, include various views of Robey engines of the high speed horizontal and high speed vertical open types, driving dynamos, alternators, &c., for electric lighting work. The boiler section describes a variety of types, locomotive, Cornish, Lancashire, marine multitubular, externally-fired multitubular, and vertical. Particulars of pumps and water-heaters are followed by some tables of generally useful statistical information, some notes on rope and belt driving, all prepared in handy form to assist engineers and others when inquiries are before them or orders have to be placed.

To tell of the enormous proportions of the undertakings of the Allgemeine Elektricitäts Gesellschaft in Berlin, is to tell an oft-told tale, but those who are anxious to get an idea on this point will be able to obtain it from a descriptive catalogue which we recently received from the Electrical Company, Limited, whose connection with the Berlin company is now matter of common knowledge. The illustrations, which are most attractively executed, show the various works, the plant exhibited by the company at the Paris Exhibition, and central stations equipped by the company. Another publication which is also before us from the Electrical Company shows the Allgemeine Pavilion at Paris, where Nernst lamps were on view.

Mr. Fairbank Brearley, of Central Engine Works, Shipley, recently sent to us a copy of his list of self-contained economical steam engines, in which horizontal, horizontal tandem, horizontal side by side, and horizontal high pressure Corliss steam engines are given in specification and other descriptive form, and illustrations appear of all types mentioned. We understand that not long since Mr. Brearley dispatched to France a pair of Corliss cylinders for working at 150 lbs. pressure, which are to be fixed on to a certain engine in substitution for others. The engine is 360 H.P., and drives electric lighting plant along with other load. These new cylinders were fitted with the maker's very latest automatic Corliss trip motion, which is claimed to have fewer working parts than any other in the market. The "C. & K." types of Brearley engines are also used for small electrical installations.

Messrs. W. H. Wilcox & Co., Limited, have issued in accordance with their usual custom a Date Remembrancer for 1901, with monthly sheets.

Messrs. Mackey's Electric Lamp Company, Limited, of Bermondsey, have issued an illustrated price list of their incandescent lamps. The opening pages contain some notes of general information useful to lamp buyers and users, these including tables showing the approximate currents of lamps at various voltages, candle-powers and efficiencies. A number of very neat illustrations of different shaped lamps for various candle-powers and voltages are given; they comprise standard lamps, high voltage lamps, and special and fancy ditto.

The Niles-Bement-Pond Company, of New York, recently brought out a very fully illustrated *brochure*, in which are shown iron and steel-working machinery, steel hammers, and hydraulic machinery manufactured by them, and now doing service in various large and important factories and works in England, America, Russia, Germany, Copenhagen, Japan and elsewhere. The illustrations suffice to indicate the nature of the very large operations of Messrs. Niles-Bement-Pond Company. Our copy of this production comes to hand from Mr. W. S. Accles, M.I.M.E., of 23 and 25, Victoria Street, S.W., who is the company's manager for Great Britain.

Berlin Westinghouse.—We are informed that a company has been formed in Berlin with the title the Westinghouse Electricitäts Actiengesellschaft, and the address 19, Jagerstrasse, Berlin W., to carry out electrical installations of all kinds on Westinghouse lines.

Electrical Illumination Effects.—In further reference to the "E.L.B." system of electric lighting, the new company which has lately been formed to exploit the work under the title "Electric Lighting Boards (British Manufacturing Company), Limited," has made a most effective start by supplying the large quantities of patent strip used in the great Palace of Glass scene in the Drury Lane pantomime, and in the marvellous Ball Room scene at the Hippodrome. Effects of such brilliance would have formerly been quite impossible on account of the expense. At the Hippodrome the British Electric and Telephone Company applied the new strips, and at Drury Lane Messrs. Salviati & Jesurum did the installation work, in both cases in consultation with Mr. Julian Halford, the company's manager, and inventor of several of the accessories used in connection with the system. These two very comprehensive applications under particularly difficult circumstances and at very short notice, show the great use of the system where time and economy are of importance, quite irrespective of any question regarding the possibility of a rapid variation in the position of the lights. Although the company's system has only been before the public for a few weeks, we are informed that the manner in which it has been received has already led the company to extend its factory accommodation to some large premises at King's Cross, whilst retaining its showrooms and West-end workshops at 18, Dean Street, Soho, W.

Fire Prevention Section at the Building Trades' Exhibition.—In further reference to the special "Fire Proofing" Section at the Building Trades' Exhibition which is being organised under the auspices of the British Fire Prevention Committee, the executive of this body at a meeting last week, presided over by Mr. Edwin O. Sachs, decided to invite numerous representatives of the municipal, technical, insurance, and industrial interests concerned to visit this elaborate demonstration of means and ways for reducing the modern fire risk. Among those to whom invitations are being issued are the provincial chairmen of Works Committees, engineers of the large dock and railway companies, principals and masters of the technical college and polytechnics, &c. Special arrangements are being made by which the visitors will have every facility for studying the subject, and the Committee will, no doubt, also entertain at their new testing station at Westbourne Park. A Sub-committee has been appointed to take charge of matters relating to the section, comprising Mr. F. Hammond (chairman), Mr. Max Clarke, Mr. Frederic R. Farrow, Mr. Chas. E. Goad, Mr. Ellis Marsland, and Mr. Edwin O. Sachs, with Mr. H. G. Montgomery as business manager. Particulars of the general arrangements are obtainable from the Committee's offices at 1, Waterloo Place, Pall Mall, S.W.

For Sale.—The British Electric Traction Company is offering for sale 391 tons 14 cwt. of cast-iron socket and spigot pipes, as mentioned in an advertisement in this issue.

German Depression.—*Commercial Intelligence* says that the "pronounced depression in German business enterprises generally has been reported on to the Washington State Department by United States Consul, Albert, at Brunswick. In building, in railroad projects, in the construction of electrical and street railroads, and in projected electrical plants for lighting, there has been a decrease, as compared with 1899, of from 30 to 60 per cent. The number of projected gasworks is almost a third less, and in mining and smelting, metal manufacture, breweries, and waterworks, there has been a considerable falling off. The Consul characterises the depression as the natural reaction after so much prosperity in 1899, and says that Germany never was so flourishing as during that year."

Liquidations, Dissolutions, &c.—The petition of Messrs. Glyn, Mills, Curry & Co. for the compulsory winding-up of the River Plate Electric Light and Traction Company, Limited, was mentioned before Mr. Justice Wright in the Companies' Winding-Up Court on Wednesday by Mr. Eve, Q.C., who appeared for the creditors. The learned counsel said the petition had been standing over for a considerable time, and a gentleman had been sent out to Buenos Ayres. He had now returned and had made a report which required consideration. The company required a considerable sum of money, and the directors were considering whether they would find it and put the company out of its difficulties. He asked that the matter should stand over until the first petition day of next sittings. There being no objection, his Lordship granted the application.

A petition was presented by Volenite, Limited, before Mr. Justice Wright on Wednesday for the compulsory winding up of the Rhea Insulite Syndicate, Limited. Counsel for the petitioning company said that large affidavits had been put in that morning, and he asked that the petition should stand over for a week. His Lordship: On what grounds? Counsel said the company disputed the claim and said they were perfectly solvent. Arrangements, however, would be made to meet the debt. His Lordship granted the adjournment.

The partnership hitherto existing between Mr. J. E. Spagnoletti and Mr. Joseph Crookes, trading as J. E. Spagnoletti & Crookes, Goldhawk Road, W., has been dissolved by mutual consent. Mr. J. E. Spagnoletti will continue the business, in conjunction with Mr. H. M. Bayly, who for many years has acted as manager, as J. E. Spagnoletti & Co., at the same address.

The Queen's Dock Electric Works, Limited, met at Kitchen Street, Liverpool, on December 28th, and resolved upon winding up. Mr. S. B. Simmons, of Liverpool, was appointed liquidator.

New Cable Factory for Spain.—A cable factory on an immense scale is going to be erected at Bilbao, in Spain, and is owned by Spanish business men and German engineers. All kinds of cables for submarine purposes, electric railways, &c., will be produced, and it is considered possible to make them cheaper in Spain than anywhere else. The name of the new firm is Sociedad Franco-Espanola de Trefileria, Cableria, y Tranoas Aereas, and the share capital is £36,000. A second undertaking in connection with the former will be a factory for copper wires and cables, called Cables-Electricas de Algarta, and in a suburb of Bilbao an electric motor factory will also find plenty of occupation.

Alteration of Capital.—The petition of the Electricity Supply Company, for Spain, Limited, for power to alter its capital was before Mr. Justice Wright in the Chancery Division of the High Court on Wednesday. Mr. Kirby, who appeared in support of the application, said the capital of the company was £100,000 in £5 shares, of which 100 shares were vendors' shares which were really deferred shares. There were powers under the Articles of Association for each class of shareholders to assent to any alteration of their rights. The company had issued debentures for about £250,000, and the capital had been expended mainly in the erection of electrical plant in Madrid. The company was formed 11 years ago and it had found that the greater part of its plant had been superseded, and was now of no value, with the result that the company have been obliged to obtain further capital and renew their plant almost entirely, and the old plant, which appeared in the balance-sheet as an asset, was barely worth the value of old metal.—His Lordship said he could not deal with that matter until he saw the report of the engineer.—Mr. Kirby expressed his regret that his Lordship had not received it.—His Lordship: There is an item of £29,354, which is said to represent an asset. What asset does it represent?—Mr. Kirby said those items were only put in the balance-sheet in order to account for capital.—His Lordship: It ought not to have been put on the asset side of the balance-sheet. There ought to be some explanation of it.—Mr. Kirby said the item consisted of the expenses of issuing debentures.—His Lordship said the articles gave power to reduce capital, but not to increase it. There must be further evidence as to preference shares, &c., and the matter must stand over for a week.

Wiring Work.—The National Electric Wiring Company sends us the following list of the larger contracts carried out by it during the past year, and now in hand:—

The Stanhope and Marlborough Lines, Aldershot Camp, for H.M. Government.
Amport House, Andover, Hants, for the Most Hon. the Marquis of Winchester. Wiring, &c., of mansion, stables, agent's house, &c., under the supervision of Killingworth Hedges, Esq., C.E
No. 39, Belgrave Square, S.W., for the Right Hon. Lord Digby, wiring and fittings.
The Guildhall, Gloucester.
The Free Library and Fine Art Gallery, Gloucester.
Lloyd's Bank, Gloucester.
The Town Hall, Bermondsey, S.E.
The Willesden District Council Offices, Dyne Road, Kilburn, N.W.
"Sitka," Chislehurst, for M. L. Teichmann, Esq., wiring and fittings.
The Wantage Engineering Works, Wantage, Berks, for the Rt. Hon. Lord Wantage, V.C.
No. 19, Hanover Terrace, for Captain and Lady Ruggles Brise.
No. 95, Westbourne Terrace, for the Rt. Rev. the Lord Bishop of Exeter.
"Knapdale," Tooting, for Colonel Stevens.
The Southampton Car Sheds, for the Southampton Corporation.
The new Bakery, Holbeck, Leeds, for the Leeds Industrial Co-Operative Society; 150 lights, eight motors, ranging from 1 to 16 H.P., and two electric hoists, countershafting, belting, &c.
Warren Cottage, Newmarket, for A. W. Cox, Esq.
"Severals House," Newmarket, for Sir Maurice Fitzgerald.
"La Grange House," Newmarket, for T. Jennings, Esq.
The Burlington Stores, Peterborough.
All Souls' Church, Peterborough.
The Ocean Accident and Guarantee Corporation's Offices, Hull.
"The Avenue" Newmarket, street lighting work.
The Corn Exchange, Northampton.
The Colosseum, Forest Hill, S.E.
The Chatsworth Road Baptist Chapel, West Norwood.
All Saints' Church, Gloucester.
St. Katherine's Church, Northampton.
The Electric Railway and Carriage Works, Preston.
The Rathmines Electricity Works, Dublin.
The Metropolitan Borough of Poplar (wiring supply station, borough offices and dust destructor).
St. Saviour's Church, Poplar.
The High Explosive Company, Limited, Essex.
Messrs. Bryant & May, Poplar.
Lady Wilton's residence, Merton Mowbray.
Hinck's factory, near Leamington.
The "General Wolf" Hotel, Coventry.
Messrs. A. Morton & Co.'s factory, Kallybegs; also at Carlisle.
F. C. Buchanan, Clarinish, Rowe.
Messrs. Coggings & Co.'s factory, Bedfordshire.
St. Matthew's Church, Phippsville, Northampton.
St. Martin's Church, Leicester.
St. Martin's Church, Salisbury.
The Municipal Buildings, Warrington.
T. T. Penrose, Esq., Dunvar House, Swansea.

Personal.—We hear that Mr. Morton Beales, who has for some time past been connected with Messrs. Ferranti, Limited, Hollinwood, Lancashire, has resigned his position with that company in order to join the staff of Messrs. J. G. White & Co., Limited, engineers and contractors, 20A, College Hill, Cannon Street, with whom he started his duties on January 1st, 1901.

Playtime.—The wives and children of Messrs. Crompton's employés at the Arc Works, Chelmsford, seem to have thoroughly enjoyed their annual treat last Saturday week. Tea, Christmas trees, the cinematographe, war pictures, and Punch and Judy, were some of the items in the list of attractions; the "Annual Baby Show Stakes," of course, must not be omitted.

Trade Announcements.—Mr. Alex. Jacobus has entered the firm of P. & M. Herre, incandescent lamp manufacturers, of Berlin, which he will continue together with Mr. Peter Herre.

We are asked to announce that the name of the firm James White, the well-known instrument maker, of Glasgow, is now altered to Kelvin & James White, Limited.

The firm of W. A. S. Benson & Co., art metal workers, electrical engineers and fitting manufacturers, of New Bond Street, and Eyot Works, Hammersmith, has been converted into a private limited company as from the beginning of this year. No changes have taken place in its business or management, except that the name of Mr. H. C. Marillier, formerly well known in electrical journalism, appears in the list of the directorate.

Williamson & Joseph, Limited.—A week or two ago we recorded the registration of a new company with this title, having a nominal capital of £4,000. The Court has recently sanctioned the sale of the assets of the old company (now in liquidation) for £7,500, such sale being effected through the receiver and manager for the debenture holders, but we understand that, after the various charges have been met, the unsecured creditors will get nothing, or next to nothing.

ELECTRIC LIGHT AND POWER NOTES.

Abercarn.—A joint conference of the Abercarn and Risca U.D.Cs. was held at Abercarn last week for the purpose of considering a scheme whereby both districts could be lit with electricity. It was decided to advertise for an expert to report upon the advisability of laying down a plant.

Athens (Greece).—A central electric power station is at present in course of construction at Athens for the use of the tramway and lighting services of the city and the lighting of the port of Piræus. The installation for the present will comprise two three-phase alternators of 750 KW. each.

Birkenhead.—The Electrical Committee of the Corporation has resolved to reduce the charges for electrical energy to the following scale:—Winter quarters, for lighting, first 1½ hours 6d., next hour, 3d., afterwards 1½d. per unit; for power and heating, 4d., 3d., and 1½d. Summer quarters, the same prices in terms of half an hour in each case.

Calcutta.—*Indian Engineering* says that "The popularity of electric appliances in Calcutta has in a very short space of time assumed vast proportions. . . . . There is no private house of any pretension but has its electric installation for lighting and punkahs, and it is a very insignificant public place that is not so fitted. Calcutta has certainly taken the lead in this matter among the cities of Asia."

Caledonian and Clyde Vale Schemes.—The Councils of Hamilton and Johnstone (Renfrewshire) have both decided to oppose these companies' applications for provisional orders.

Canada.—Industrial combination is at present the dominant feature of Canadian progress. Hardly an industry of consequence remains unaffected, and amalgamations are being announced with great frequency. According to the *Express* the gas and electric lighting companies of Montreal have just combined, with a capital of £4,000,000, after a commercial war, in which rates have been cut to a disastrous extent. This is the greatest combination of the kind yet made in Canada. At present the lighting and power rates of Montreal are the lowest on the Continent. The combine will increase them forthwith, as the present charges are hardly sufficient to pay dividends such as the new "community of interest" must have to be a success.

Charlton Kings.—The B. of T. has forwarded a description of the system which the Cheltenham Corporation proposes to adopt for the supply of electric energy to Charlton Kings under its extension order of 1900, and has asked for any observations the District Council had to make on the subject.

Cheltenham.—At a meeting of the E.L. Committee on the 2nd inst. the report of the borough electrical engineer (Mr. Kilgour) was considered. He recommended an expenditure of £14,511 on machinery in view of the tramway, £9,744 on additional street arc lamps, and £780 on private extensions. These recommendations were adopted. It was decided that application be made to the Local Government Board for sanction to borrow £25,000, and that all arc lamps in excess of 300 be charged at the reduced price of £14 10s. each per annum.

Cleveland and Durham Power Scheme.—A Bill has been deposited for introduction into Parliament next session under which it is sought to incorporate a company under the name of "The Cleveland and Durham County Electric Power Company." The general purposes of this company, says the *Financial Times*, are to produce and supply electrical energy or power in bulk to authorised distributors for lighting purposes, and to persons for power purposes only. The area within which the company may carry on business comprises the whole or portions of the unions of Easington, Sedgefield, Hartlepool, Stockton, Darlington, Teesdale, Auckland, Weardale, Lanchester, Durham and the following unions or parts of unions in the North Riding of Yorkshire: Middlesbrough, Guisborough and Stokesley. The generating or power stations are proposed to be erected on certain lands in the parishes of Witton-le-Wear, Lanchester, Consett, Hutton Henry, Woodham, Brotton and Billingham. The capital of the company is to be fixed at £1,000,000, divided into 100,000 shares of £10 each, with the right to divide these shares into preferred half-shares and deferred half-shares. Upon this capital borrowing powers are sought to be exercised to the extent of £333,000 by the issue of debenture stock.

Dalkeith.—The Burgh Commissioners have considered the agreement with Messrs. Crompton, Limited, for the lighting of Dalkeith and Eskbank with electricity, and have decided to approve of the application of that firm for the necessary prov. order. The Commissioners have also resolved that an independent electrical expert be engaged to advise as to the erection of the arc and incandescent lamps for street lighting.

Darwen.—The T.C. has decided to approve of a recommendation by the Electricity Committee that application be made to the L.G.B. for power to borrow £13,000 for increasing the plant at the electricity works.

Dumfries.—The T.C. intends to appoint a consulting engineer to report on an electric lighting scheme. The cost is estimated at from £18,000 to £20,000.

Edinburgh.—The E.L. Committee of the T.C. has agreed to recommend the appointment of a deputation to visit several English towns in connection with the provision of condensing plant for the M'Donald Road station.

Enfield.—Strong opposition has been raised to the electric light scheme promoted by the joint District Councils. In consequence of the ratepayers at a recent meeting refusing by a majority of two to one to confirm the Councils' action, a poll of the parish is to be taken next month. At a public meeting at Edmonton the project was approved, but a poll is to be taken there also.

Germany.—The establishment of a central electric lighting station in the town of Kiel (Holstein), at an estimated cost of £35,000, has just been decided upon.

Hampton Wick.—The U.D.C. has sanctioned the terms proposed by the Richmond Electric Light and Power Company for the supply of current in their district.

Harrogate.—It was stated recently at a public meeting that £70,000 had already been spent on the electric light, which was now a paying concern. It was expected that £30,000 more would be required in that direction.

Hindley.—The *London Gazette* contains notice of the application of the U.D.C. for a provisional order.

Horsham.—An inquiry was held last week on behalf of the L.G.B. by Colonel Smith, with respect to the application of the U.D.C. for leave to borrow £15,500 for the purpose of electric lighting. Mr. Hawtayne gave evidence in favour of the scheme, which was opposed by a number of ratepayers.

Irvine.—The T.C. has resolved to consider a report of Mr. Bryson on the subject of electric lighting with a view to adopting a scheme of electricity supply, and to oppose an application of the Caledonia Electric Lighting Company for a prov. order.

Jedburgh.—The T.C. last week resolved to consent to application being made by Messrs. Crompton & Co., Limited, to Parliament for a prov. order to instal the electric light in Jedburgh.

Kendal.—The T.C. has resolved to make application to the L.G.B. for leave to borrow £14,000 for the installation of electricity works, according to the scheme drawn up by Messrs. Handcock & Dykes. The following tenders were recommended for acceptance:—Contract No. 1, Messrs. Johnson & Phillips, £4,975; contract No. 2, the British Insulated Wire Company, £2,965 3s. 6d.

Kingston-on-Thames.—A L.G.B. inquiry was held last week in connection with the proposed new loan of £17,800 for extensions of electric lighting. The present outstanding loan for this purpose is £51,866, and of the additional amount now asked for, £6,750 is for extension of buildings, £3,850 for additional boilers, £4,400 for other machinery, and £2,800 for a special arc lighting installation. Current is now supplied to 20,000 8-C.P. lamps, which is double the number used in 1897. When the new arc installation is completed, there will be 76 arc lamps in the streets, run in four series of 19 lamps, and illuminating all the main roads in the borough.

Liverpool.—The Electric Power and Lighting Committee of the Corporation, under the chairmanship of Mr. S. W.

Higginbottom, M.P., has decided to make application to the L.G.B. for sanction to the borrowing of £300,000 for purposes connected with the supply of electrical energy.

London.—BATTERSEA.—The Lighting Committee of the Borough Council has had under consideration the question of installing electric light in private premises in Battersea upon the prepayment and easy payment systems of supply. Having regard to the delay which would necessarily take place if the Council waited to obtain power to carry out the work itself, it has been decided that alternative schemes be invited for the fitting up of consumers' premises for electricity free of all initial cost to the Council or the consumer.

HACKNEY.—The Lighting Committee has recommended the Council to adopt the following scale of charges for electricity:—For private lighting, 4d. per unit; for motive power, 2d. per unit. This is, perhaps, the lowest scale on record for a flat rate in the case of an entirely new concern.

SHOREDITCH.—The Finance Committee, at a meeting of the Borough Council on Tuesday, reported having had before them a letter from the chief electrical engineer of December 18th, together with a statement with regard to live steam supplied by the electricity works to the Hoxton Baths and Washhouses. The statement showed that the estimated cost from March 26th to November 9th, 1900, amounted to £574, this sum including coal, stokers' wages, cleaning boiler, water, interest on capital, depreciation, repairs, and insurance. A report received from Mr. Newton Russell, the engineer, stated that the charge was fair and reasonable, and was arrived at on a proper basis, and the Committee recommended that the charge of £574 should be paid by the baths and washhouses revenue account. Mr. Wakeling, who contended that the charge was too high and incorrect, proposed that the recommendation should be referred to the Lighting Committee with a view to ascertain, in conjunction with the Baths Committee, the exact cost of the live steam supplied to the baths. The amendment having been seconded, Mr. H. Winkler stated that the question had been before the Lighting Committee. The engineer had carefully noted the facts and figures in connection with one boiler, and he had arrived at the figures before the meeting, the basis of which had been approved by the late Vestry. After further discussion, the amendment was defeated, and the motion was then agreed to. The Finance Committee further stated that consideration had been given to a statement of receipts and expenditure in connection with the refuse destructor from March 26th, 1896, to September 29th, 1900. It appeared that the expenditure amounted to £23,808, and the receipts to £22,561, leaving a balance of £1,247, and the committee recommended the Council to apply to the London County Council for sanction to borrow that sum. In reply to questions, Mr. E. T. Adams, borough treasurer, stated that the figures referred to capital account. Mr. Winkler remarked that the report surprised him, because the Lighting Committee knew nothing about the matter. Mr. S. G. Porter, as an amendment, proposed that the matter should be referred to the Lighting Committee for investigation, and after further discussion the amendment was carried.

The Lighting Committee submitted a report in regard to a matter raised in December respecting the tenders received for the supply of steam engines and dynamos, a list of which was given in the last issue of this journal. The Committee found that the representative of Messrs. Victor Coates & Co. had called at the generating station in reference to his firm's tender for the new plant, and that having accidentally met the Mayor in the office lobby, he apparently went away with the impression that he had seen Mr. Trowbridge, owing to a misunderstanding in reading the memorial tablet outside the building. The company subsequently sent some information regarding their engines addressed to Mr. Trowbridge, and the Committee mentioned that Messrs. V. Coates & Co. had stated that it was their practice to forward such information when submitting tenders, and, if possible, to dispatch a telegram at the last moment to prevent their name from being overlooked. The company had expressed regret for the misunderstanding and inconvenience which had been caused, and the Committee recommended that the question should be discharged. This was agreed to without discussion.

Manchester.—At a meeting of the City Council last week, Dr. Bishop, chairman of the Electricity Committee, proposed the adoption of a recommendation of that committee to authorise application to be made to the Local Government Board for sanction to the borrowing of £500,000 for electricity purposes, in order to enable the committee to meet obligations into which they had entered, not only with the Tramways Committee, but with a number of authorities of adjoining districts. The sum asked for did not include any of the expenditure which would be incurred by the erection of the Stuart Street station. It would cover, however, in accordance with the estimate of the electrical engineer, (1) the balance of the three-phase mains required in the city up to the sub-stations nearest to the city boundaries. He had also made allowance in those mains for carrying them forward into the outlying districts, the provisional orders of which the Corporation had agreed to take over, but he had not provided the three-phase mains in those outlying districts, nor the mains connecting those districts to the nearest sub-station. He had, however, provided the three-phase mains within Heaton Norris and the connecting link between Heaton Norris and the city situated in Levenshulme. (2) Low pressure feeders. (3) Tramway feeders in the city, Moss Side, Withington, Levenshulme, and Heaton Norris. (4) New distributing mains in the city, Moss Side, Levenshulme, and Heaton Norris. (5) Conductors for potential wires, street lighting, and telephone cables. (6) New services in the city and in Moss Side, &c. (7) Meters in the city and Moss Side, &c. (8) A lump sum to cover small extensions in various streets as required. The committee thought it necessary that they should be in a position to extend their operations rapidly, because otherwise they would fail in obligations to which they were pledged, and would be landed in a dilemma. The resolution was passed.

Middlesbrough.—At a meeting of the T.C. last week a specification and estimates for an additional set of plant and extensions to mains were ordered to be prepared. The chairman of the E.L. Committee stated that they had applications for 10,000 lights, and they could not meet this demand with their one set of plant and reserve set. It was proposed to supply power during the day at an all-round figure of 2d. per unit.

North Down (Ireland).—The North Down Tramway Company has offered to undertake the electric lighting of Bangor, Groomsport, and Donaghadee, in connection with the electric tramway scheme which it has in hand.

Nuneaton.—The Nuneaton and Chilvers U.D.C. has resolved that the electric works be extended at an outlay of £2,509, the floors to be raised above the level of the recent flood.

Ossett.—The T.C. is to unite with other local authorities in opposing the Yorkshire Electric Power Bill.

Peterborough.—A proposal to adopt electricity for street lighting is receiving the favourable consideration of the T.C., which is about to seek powers to borrow money for extensions of the new electricity works described elsewhere in this issue.

Since the supply was commenced there has been a growing demand for the new illuminant by shopkeepers, and at a meeting of the T.C. last week, Mr. J. C. Gill, the borough electrical engineer, presented a report stating that in order to meet the demand it was necessary to increase the plant as follows:—Lancashire boiler and setting, £700; 120-KW. steam dynamo, £1,500; spare armature for dynamo, £200, and minor details. A report was also presented showing how electric lamps could be used for street lighting at a great saving to the ratepayers, and the Council decided to apply for power to borrow £11,000 to further develop the electric light undertaking.

River Shannon.—A special meeting of the Limerick Harbour Board was held last week to consider the proposals of the Shannon Water and Electric Power Company, but was adjourned for the purpose of holding a joint meeting of the Board and the Corporation.

Scarborough.—The sub-committee which has had the matter in hand has recommended to the General Purposes Committee that the undertaking of the Electric Lighting Company should be purchased upon terms settled by the committee. The committee, however, deferred the minutes for further consideration.

Stafford.—At a meeting of the T.C. last week a letter was read from the L.G.B. sanctioning a loan for £10,000 for electricity purposes, on the condition that the roof of the new buildings be slated.

Swansea.—Application has been received by the engineer for 7,500 lamps, and it is believed that the total applied for will amount to 13,000. Opposition to the South Wales Electric Power Distribution Bill has cost Swansea about £279; Cardiff's share is £978, Newport's £258, and Barry's £171.

Thaon (The Vosges, France).—The Municipality has decided to light the town by electricity.

Vogogna (Italy).—A project and a request for concession for the derivation of water from the Arsa torrent, in the territory of Rumianca, Italy, has been presented by the engineers, Marchesi, Scartazzini, and Busser, with the object of developing electric energy, which it is proposed to transmit to Vogogna.

Wakefield.—The General Asylums Committee of the West Riding County Council, in consequence of the many electrical installations now erected and in course of erection in connection with the asylums, has determined to establish an electrical department, and has appointed Mr. H. de Grave as electrical clerk of works at a salary of £3 10s. per week.

Walsall.—The E.L. Committee recommends that application be made to the L.G.B. by the T.C. for leave to borrow a further sum of £3,000 for electricity supply.

Wellingborough.—The U.D.C. has consented to the transfer of the order obtained by the Electrical Power Distribution Company, for the purpose of supplying electricity, to the Northamptonshire Electrical Power Distribution Company.

Yarmouth.—Sanction has been given to a loan of £27,000 for extensions of the Corporation electricity works, with a view to arc lighting and traction.

Yeadon.—A conference of local authorities is to be held at Yeadon to consider the proposals of the Yorkshire Electric Power Syndicate.

ELECTRIC TRACTION NOTES.

Angers (France).—A line of tramway to be worked electrically is to be constructed from the Place du Ralliement to the Church of St. Jacques. The concession has been given to the Compagnie des Tramways Electriques d'Angers.

Accrington.—The "out-of-dateness" of the steam trams and the desirability of changing over to electricity were the subjects of discussion at the T.C. last week, when Councillor Dewhurst brought forward a motion to appoint a committee to consider the best means of carrying the change into effect. After some discussion, however, the motion was withdrawn. It seems that the Legal and Parliamentary Committee is watching the matter.

Birkenhead.—At an adjourned meeting of the T.C., a discussion took place on the minutes of the Tramways Committee's proceedings coming up for confirmation. The subject had been considered at the previous meeting. The minutes contained a recommendation, that the fares on the new electric tramways should be:—Between New Ferry and Green Lane, 1d.; between Bedford Road and Woodside Ferry, 1d.; and for any greater distance, 2d. At the previous meeting Alderman Shaw had moved that the recommendation as regards fares, be referred back, and Mr. Wall had seconded.—Speaking upon the subject, Mr. Wall said he had calculated that £70,000 would have to be spent on the New Ferry line before it was completed, and that the interest and sinking fund on that amount would be something like £4,000. Roughly, the traffic expenses amounted to about 4½d. per mile, and 4½d. per mile meant 1s. the single trip. The reduction of the 2d. fares to 1d. would not increase the traffic 50 per cent. as would be necessary to make the same profit as formerly. He urged the Council to go in for a slow policy and reduce the fares as the tramways became more and more successful.—After discussion, the minutes of the Tramways Committee were confirmed.—Mr. A. E. Gria moved that the tram tracks in Borough Road, Conway Street, and Camden Street, be paved with wooden blocks instead of stone setts, on the ground that he could not see the justice of paving the tramway tracks named with granite setts, and almost all the other tracks in the town and suburbs with wood blocks.—The motion was carried by 20 votes to 13.

Cork. — The returns of the Cork Electric Tramways for the past year have been good. They show an increase of £1,652 on the previous year. In 1900 the traffic returns were £412 per week, as against £380 in 1899, an increase of £32 per week. Cork is not a large city, and this steady increase is notable. £32 per week means 1,000 additional travelling daily over the system. At the quarterly meeting of the Cork County Council, the Irish Electric Railway Company, Limited, asked the approval of the Council for the construction of an electric tramway from Kenmare and Castletownbere to Bantry, at a cost of between £600,000 and £700,000. It is expected that this line will greatly develop tourist traffic. The General Electric Company (Ireland), Limited, also applied for the approval of a scheme to construct a tramway between Middleton, Cloyne and Ballycotton at a cost of £50,000. Both schemes were referred to a committee, the Council being favourable to the projects.

Germany.—A powerful syndicate of German electricians and engineers has been formed in order to study the problem of making electricity the motive power in passenger expresses. The Emperor William has promised Herr Rathenau that he will support the project. A beginning is being made by the construction of two electric coaches, each of which is to hold 50 people. They will be tried on the military railway from Berlin to Zossen, a distance of some 20 miles, and if the experiment is a success, electric expresses consisting merely of one coach each will be run at a speed of from 125 to 160 miles an hour (? will it) between the great cities of the empire at intervals of a quarter of an hour.

Lake District.—The British Electric Traction Company is reported to have definitely abandoned the scheme for presenting a Bill in Parliament for running electric trams with overhead wires between Bowness, Windermere, and Ambleside.

Leeds.—The earnings of the Leeds electric trams under the halfpenny system (York Road district) during the past six months have averaged a fraction under 11d. per car per mile. This is about 3d. less than in the case of the other routes.

Leith.—The Edinburgh Street Tramways Company has brought the question of using electricity (trolley) on the Leith Walk section, before the T.C. The company suggests that perhaps suitable arrangements can be made for taking a supply of energy from the Corporation electricity works.

Liverpool.—What is termed the "outer belt" of the Liverpool electric tramways system has been completed and opened for traffic. The belt forms a circular route to and from the eastern suburbs of the city. The cars proceed from South Castle Street, in a southerly direction, and gradually work round to the south-east and east districts. A long cross route traverses the eastern suburbs and the cars going northwards return to the city by that route. Five penny stages have been formed, the whole covering the complete belt. There is yet another belt-route to be completed. At present there are 85 miles of single and 40 miles of double electric track in Liverpool, and another five miles are in course of construction. The whole of this extensive system has been constructed since 1898. November, 1898, the first electric cars began to run on a trial route of about 2½ miles, between the centre of the city and the south end. 260 cars are now running on the Liverpool system and the number will shortly be increased to 300.

The falls of snow in Liverpool on Tuesday and Wednesday of last week aroused the interest of officials and public as to how the electric car service would fare. For some years past the Liverpool Corporation have followed the plan of salting the streets after a a fall of snow, and then setting the machine brushes and a thousand or more men to work to clean the streets of the slush formed by the melting snow. For the electric car service, snow ploughs are provided for use when the fall of snow may be heavy. Last week the old plan of salting the track was resorted to. Some 50 horses and carts were sent over the 80 miles of single track with salt, when the snow began to fall, and within an hour the whole had been well salted. The snow quickly melted down, and the streets were cleared by brushes and hose pipes, the latter being used for washing down.

Accidents, most of them of a minor kind, are now of almost daily occurrence in Liverpool. Generally they are caused by carts or other conveyances which have been on the car track, failing to get clear of the track when warned by the drivers of the cars, and collisions consequently occurring. Small mishaps with the overhead wires are also of frequent occurrence. On Friday last, a stoppage was caused in Tithebarn Street on the Seaforth route, by the head of a trolley jamming in a frog at the corner of Moorfields, and causing a main supporting wire and two stays to give way. The head of the trolley was broken, and contact was destroyed, The car had accordingly to be pushed back to the main depôt. Later in the day a similar accident occurred at the end of Dale Street, opposite the Town Hall. On Monday at noon a short stoppage was caused in Dale Street, near the Town Hall, by the displacement of a stay-wire at the bend of the track.

The receipts for the fortnight ending January 5th, were £17,534, an increase upon the corresponding fortnight last year, of £3,800. The number of passengers carried was 3,754,478, an increase over the corresponding fortnight of 1900, of 1,174,375. The mileage run was 384,236 miles, an increase of 72,151.

London.—Notice has been given at the Private Bill Office of the Houses of Parliament of opposition to three important electrical schemes affecting London. These are the London County Council (Tramways and Street Wideaings) Bill, the West and South London Junction Railway Bill, and the London United Tramways Bill. In the case of the London County Council Bill one memorial, and in the London United Tramways four memorials, were lodged against the Bills, all on the ordinary grounds.

Pollokshaws.—At the last Town Council meeting it was intimated that the Glasgow Corporation had agreed to run their system of electric cars from Shawlands Cross along the Barrhead Road to the Round Toll, with the probability of further extensions later on.

St. Helens.—The official inspection of the newly-opened line of tramways from St. Helens to Rainhill, Whiston, and Prescot, was made on Tuesday last week, by Lieut.-Colonel E. Von Donop, representing the Board of Trade.

Sunderland.—Although one section of the Corporation electric tramways has only been open five months, and another about two months, the committee are about to recommend the Council to enter into contracts for extensions. Other three sections are expected to be open to the public within the next six weeks, and then all parts of the town will be served with electric trams. Despite a loss on the horse traction, owing to the delays caused by relaying the lines, the undertaking for the first year shows a clear profit of over £3,000; and it is computed that when the electric trams are in full working order, the profits will be at least £10,000 annually. It is stated that on the two sections now open the receipts, which were estimated at 10d. per mile, proved to be 1s. 6d. The Corporation decided to spend £27,000 in extensions.

Underground Electric Railways.—Owners of property in the western end of Fleet Street have formed a very influential committee to watch the progress of the Victoria, City and Southern, and the Piccadilly and City Railway Companies' Bills and to protect the interests of the owners of property in Fleet Street affected by the proposed works.

Willesden.—The residents have polled as to whether they will or will not have municipal electric tramways. There is a majority of 1,734 against the scheme.

TELEGRAPH AND TELEPHONE NOTES.

Continental Telegraphs.—Russia and Bulgaria will shortly conclude a postal and telegraphic treaty providing for the laying of a cable between Odessa and Varna.

French Atlantic Cable.—It is stated that the French Government have given orders for the immediate manufacture of the new Atlantic cable which they propose to lay. It will be made at the extensive cable works at Calais, which were partially destroyed by fire a few months ago, but have since been reconstructed.

Pupin Telephony.—Press telegrams from New York state that, according to the current issue of the *Electrical Review*, the American Telephone and Telegraph Company, parent of the Bell Company, has purchased the patents of Dr. M. I. Pupin, of Columbia University, which, it asserts, cover the art of ocean telephony, and will enable telephone messages to be sent over any length of landlines. "It is added that the sum of $200,000 has been paid to Dr. Pupin for his invention, with an annual salary of $7,500 during the life of the patents. Two of these patents were issued in June, 1900, for the invention, which is described at length, and characterised as one of the most brilliant discoveries of Dr. Pupin. In experimenting with artificial conductors, Dr. Pupin found that it was possible to telephone over vastly greater lengths of cable than had been feasible before, and easily to make any desired length of telephone circuit. He has shown a design for induction coils to be introduced at appropriate intervals in a trans-Atlantic cable, which would allow telephonic conversation to be held across the ocean."

Rome-Paris Telephone.—A Rome Press telegram states that work is now in progress upon a line of telephone between this city and Paris, *viâ* Turin and Lyons.

The Telegraph Wire Export Trade.—December proved to be a very quiet month as regards the exports from this country of telegraphic wire and apparatus connected therewith, the month's shipments only reaching a value of £39,166, as compared with £230,430 in the preceding month. Taking the returns for the whole of the past year, however, they show that in this branch of the export trade, 1900 has been one of the busiest years on record, the shipments during the 12 months having reached a total of no less than £2,853,325, which compares with only £1,406,734 in 1899 and £985,283 in 1898.

Telegraphic Delays.—A reply has been received by the Liverpool Chamber of Commerce from the Marquis of Londonderry, to the memorial from the Chamber, dated December 14th last, *re* telegraphic delays between Liverpool and the Continent. The Postmaster-General in his reply states that the department has done everything in its power to render the direct wire to Hamburg fit for working by the Duplex-Hughes system, and has arranged with the Telegraphic Administration of Germany for the use of one of the best wires in the cables between England and that company. It had, unfortunately, been found that the working of the Duplex-Hughes system was still impossible, and the reason of this had not yet been traced. The Postmaster-General had arranged with the Telegraphic Administration of Germany that experts of the two countries should meet and try to overcome the difficulty. The Telegraph Administration of Belgium had raised the question whether, in the interests of commerce, a telephone cable, rather than a telegraph cable, ought to be provided, and experiments had been conducted to ascertain the best type of cable for the purpose. The Postmaster-General stated he would use every means in his power to maintain a sufficient number of wires for the proper working of the telegraph and telephone business of the country.

Telegraphic Interruptions and Repairs:—

CABLES.	INTERRUPTED.	REPAIRED.
AFRICAN—St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
SOUTH AMERICAN—Pará-Maranham	March 1, 1900	
Pernambuco-Ceara	Nov. 29, 1900	
Cayenne-Pinheiro	Nov. 26, 1900	
Payta and Barranco	Jan. 7, 1901	
Falmouth-Bilbao	Dec. 28, 1900	
Latakia-Cyprus	June 20, 1899	
Marseilles-Barcelona	Jan. 7, 1901	
LANDLINES:—		
SOUTH AMERICAN—Interior of Colombia landlines	Nov. 19, 1900	
Ecuador landlines	March 3, 1897	
Landlines west of Barquisineto and Coro	Nov. 1, 1900	
Barcelona (Venezuela)-Ciudad (Bolivar)	Nov. 1, 1900	
Communication with Carthagena and Baranquilla	Dec. 8, 1900	
WEST INDIAN—Landlines to Baracoa, Guantago and Sagua de Tanamo	Nov. 12, 1900	
Landlines between Puerto Plata and San Domingo City	Nov. 20, 1900	
CHINESE—Tientsin-Pekin	June 11, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin and Taku *via* Helampo	June 18, 1900	
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	
Communication between Saigon and North Annam and Tonkin	Oct. 23, 1900	
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 26, 1900	
Indo-European lines between Odessa-Kertch	Jan. 15, 1901	Jan. 15, 1901

Wireless Telegraphy.—The Paris correspondent of the *Morning Post* says that the French Mediterranean Squadron has received orders to engage in a decisive series of wireless telegraphy experiments. All the vessels composing the fleet will be fitted with Marconi apparatus. The experiments made hitherto, which have been conducted with much secrecy, have demonstrated the practicability of communicating at distances up to 20 miles. The Mediterranean Squadron is also to experiment with an improved system of electric light signals.

A dispatch from Rome says that the telegraphic cable uniting Sardinia with the Island of Carloforte having been interrupted, Signor Pascolato, Italian Postmaster-General, has ordered experiments to be carried out between the two islands with the Marconi apparatus in order to see whether these can be used in all weathers as a substitute for the submarine cable.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—February 8th. The E.L. Committee wants tenders for surface condensers, air and circulating pumps. See "Official Notices" January 11th.

Aberdeen.—February 13th. The Tramways Committee wants tenders for electrical equipment of the Bathing Station route, comprising overhead material and underground cables. Poles provided by Corporation. See "Official Notices" to-day.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (8s. 4d.). Information from the manager of the office of Electricilty, Achterburgwal, 213, Amsterdam.

Batley.—February 9th. The Corporation wants tenders for three high speed triple-expansion steam dynamos, one balancer, and one motor-generator. See "Official Notices" January 11th.

Battersea.—February 1st. Tenders are wanted for ordinary and prepayment electricity meters. Consulting engineers, Messrs. Kennedy & Jenkin.

Bournemouth.—March 2nd. The T.C. invites tenders for 42 electric cars. See "Official Notices" January 11th.

Bournemouth.—March 4th. The T.C. wants tenders for three steam dynamos, and two steam-driven surface condensers. See "Official Notices" to-day.

Bradford.—February 2nd. The Tramways Committee invites tenders for overhead equipment for 5 miles of tramway. Particulars, &c., at the Surveyor's office Town Hall, on payment of £3, returnable as usual.

Brighton.—January 28th. The Council wants tenders for three direct coupled compound-wound steam dynamos (Willans engines), tramway switchboard and negative booster for the North Road electricity works. See "Official Notices" January 11th.

Brighton.—February 14th. The Council wants tenders for overhead trolley construction, and equipment of routes; also for feeder, distributing, test and telephone cables. See two "Official Notices" to-day.

Bristol.—The Electrical Committee is going to advertise for tenders for the supply of coal conveyors.

Burnley.—February 7th. The Corporation wants tenders for the supply of a traction switchboard. See "Official Notices" to-day.

Canterbury.—January 30th. The Lighting Committee wants tenders for Lancashire boiler, 300-KW steam dynamo, piping, condensing plant, and switchboard extensions. See "Official Notices" January 4th.

Colne.—January 19th. The Electrical Committee wants tenders for switchboard, balancer-booster, paper insulated mains, earthenware conduits, superheater, battery, ejector condenser, and motor pump. See "Official Notices" January 4th.

Croydon.—January 21st. The Council wants tenders for an overhead travelling crane for the electricity works. See "Official Notices" January 11th.

Denmark.—January 21st. The municipal authorities of Copenhagen are inviting tenders until the 21st inst., for the supply of a battery of accumulators for the central electric lighting station. Information from the office of Electricity, 30, Gothersgade, Copenhagen.

Eccles.—January 28th. The Corporation wants tenders for a 40-KW steam alternator. See "Official Notices" to-day.

Edinburgh.—February 9th. The Corporation invites tenders for an engine and dynamo for the McDonald Road electricity works. See "Official Notices" January 11th.

France.—January 22nd. Tenders are being invited until the 22nd inst., by the French Minister of Posts and Telegraphs in Paris, for the supply of 170 tons of iron wire 8 mm. diameter; 50 tons ditto 7 mm. diameter; 60 tons ditto 5 mm. diameter and 200 kilometres of submarine cable core. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Glasgow.—Tenders are wanted for lighting the grounds, the Grand Concert Hall, and the pavilions in the Grounds of the Glasgow International Exhibition.—Apply to the engineer, Mr. John Young, 4, West Regent Street, Glasgow.

Glasgow. — January 18th. The Corporation wants tenders for the supply of telephone apparatus in connection with the Pinkston tramways power station. See "Official Notices" December 28th.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Hull.—February 8th. The Works Committee wants tenders for a multipolar generator, to be coupled direct to a Belliss high speed engine, for the tramways undertaking. See "Official Notices" to-day.

Launceston (Tasmania).—The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Luton.—March 4th. The T.C. wants tenders for electrically lighting the Council Chamber, Town Hall, Free Library, Corn Exchange, and Baths. See "Official Notices" to-day.

New South Wales.—February 22nd. The *New South Wales Government Gazette* announces that tenders will be received at the offices of the Department of the Public Service Tender Board, 42, Young Street, Sydney, for the supply of (1) Telegraph material; (2) Telephone material; (3) Electric light material, all for the years 1901-2. Tender forms may be obtained and samples seen at the office of the Chief Electrican, General Post Office, George Street, Sydney. Samples may also be seen at the Postal and Electric Telegraph Stores, George Street, Sydney. The conditions as published in the *Gazette* may be examined on application at the Commercial Intelligence Branch, Board of Trade, 50, Parliament Street, London, S.W., any day between the hours of 10 a.m. and 5 p.m.

Oldham.—January 29th. The Electricity Committee wants tenders for two 600-I.H.P and four 1,200-I.H.P. engines, each direct-coupled to a continuous current dynamo. See "Official Notices" January 4th.

Pietermaritzburg.—The *British and S.A. Export Gazette* says that the London agents for the Pietermaritzburg Town Council will shortly place a large order for electric light meters.

Poplar.—February 6th. The Guardians want tenders for brickwork, two Lancashire boilers, and economiser. See "Official Notices" to-day.

Rotherham.—January 19th. The Corporation wants tenders for the supply of a number of electricity meters. See "Official Notices" December 28th.

Sheffield.—January 21st. The Tramways Committee wants tenders for a low speed vertical engine for driving a 1,000-KW. tramway generator. See "Official Notices" December 21st.

Southport.—January 21st. The Tramways Committee wants tenders for poles, brackets, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes for the tramways department. See "Official Notices" January 4th.

Spain.—The municipal authorities of Balazote (province of Albacete) have just invited tenders for the concession for the electric lighting of the town during a period of 40 years.

Sunderland.—February 1st. The Corporation wants tenders for condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane for the electric light station. See "Official Notices" December 28th.

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Tynemouth.—January 31st. The Corporation wants tenders for a 450-KW. steam dynamo. See "Official Notices" January 11th.

Victoria.—January 29th. Tenders will be received until Tuesday, January, 29th, for the supply and delivery of 20 miles of underground telephone cable. Specifications may be seen at the telegraph engineer's room, General Post Office, Melbourne. Tenders to be endorsed "Tender for 20 miles underground cable," and addressed to the Honourable the Postmaster-General, Melbourne. The *Victorian Government Gazette* containing the above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament Street, any day between 10 and 5.

Wigan.—February 2nd. The E.L. and Tramways Committee wants tenders for two 210-KW. steam dynamos, two Korting condensers; certain piping; switchboards; feeder boosters and battery milker. See "Official Notices" to-day.

Wimbledon.—February 18th. The U.D.C. wants tenders for the supply of steam and other piping; moving boilers, pumps, &c.; also supply of surface condensing plant and two water-tube boilers for electricity works extensions. See "Official Notices" to-day.

CLOSED.

Ayr.—The Town Council has this week agreed to give the contract for the construction of permanent way to Mr. D. Murray, Glasgow, at £15,758.

Bermondsey.—Because they applied to have the words "standard wages" substituted for "trades union wages," Messrs. Crompton & Co., Limited, have lost the Council's contract for arc lamp columns, and arc and incandescent lamps, at £2,595. The contract went to Messrs. Johnson & Phillips, the next tenderer, at £2,765, because they agreed to conform to all the conditions laid down.

Birkenhead.—Messrs. Crompton & Co., Limited, have secured the contract for switchboard and instruments for the Corporation's electric station in Craven Street.

Bradford.—The Guardians have accepted the tender of Messrs. T. Sheckleton & Co. to erect a condenser house for £219 18s., and a cooling tower for £356 5s. 4d. in connection with the electric lighting of the workhouse.

Bristol.—The Electrical Committee has accepted the following tenders in connection with the Avonbank works:—Messrs. Doulton & Co., for water softeners; Messrs. G. & J. Weir, for feed pumps; and Messrs. Babcock & Wilcox, for boilers.

Cheltenham.—An order for a second 500-KW. turbo-alternator has been placed with Messrs. C. A. Parsons & Co.

Durban.—*Industries* (Natal) says that the contract for the new lighting dynamos for Durban has been amended. The two dynamos will be of 300 KW. each, and the engines of suitable capacity for 15 per cent. overload. The dynamos and engines are to be supplied by the Electric Construction Company and the engines are to be of the Willans triple-expansion type.

Kendal.—The committee recommends the Council to place the contract for the station equipment (boilers, dynamos, engines, battery, &c.) with Messrs. Johnson & Phillips, and that for mains, meters and house services with the B.I.W. Company, Limited.

London.—The St. Pancras Borough Council on Wednesday considered the following tenders for the supply of Conradty carbons during the ensuing year:—

General Electric Company (Conradty)	£833 15 0
" " " (other make)	760 12 6
Crompton & Co., Limited (Conradty)	778 6 8
Sloan Electrical Company, Limited (Conradty) (accepted)	742 10 0
De Grelle Houdret & Co. (other make)	698 15 0

Montrose.—The Montrose Asylum and Infirmary Board has agreed to accept the tender of Messrs. James Maxwell & Sons to supply a large engine at a cost of £789 10s. for electric lighting.

Newcastle.—The Council has accepted, on the advice of the New Tramways Committee, the tender of the Brockie-Pell Company, amounting to £4,095, for the supply of arc lamps for street lighting. The tender of Messrs. Callender's Cable and Construction Company for the supply of arc lamp and telephone and pilot wires, at a cost of £2,037, was also accepted.

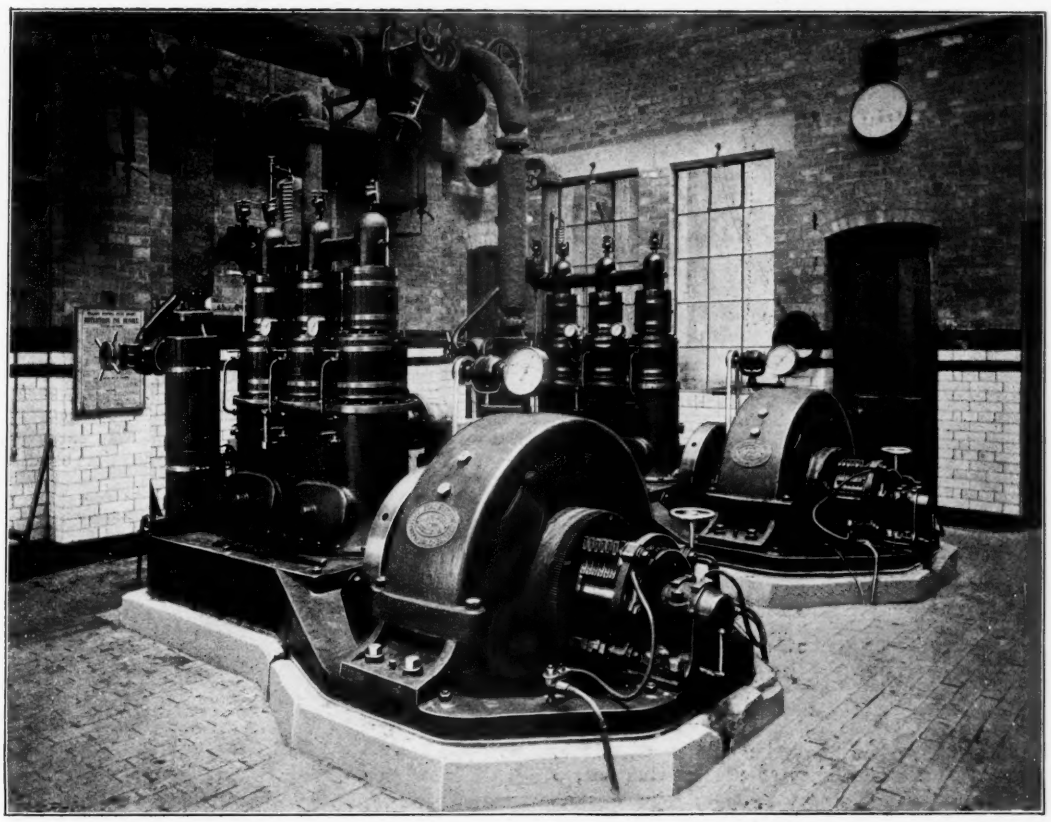
Wakefield.—The City Council has accepted the tender of Messrs. Ferranti, Limited, for a 400-KW. engine and alternator at £3,800. Mr. Wigham said that by accepting this tender the Council had effected a saving of £500. The Committee had now been converted to the belief that vertical engines were preferable to those of a horizontal type for electric lighting purposes.

Wakefield.—The West Riding County Council has accepted the tender of the Walsall Electrical Company, Limited, for the installation of the electric light at the new epileptic block of the Wakefield Asylum for £234.

Wolverhampton.—The T.C. has accepted the tender of Mr. Henry Gough for the erection of a special car depôt on the Cleveland Road site at a cost of £7,598, and also the tender of the Rex Foundry Company, Wolverhampton, amounting to £1,979 2s. 5d., for the iron and steel work required in the construction of the tram-car depôt in the Cattle Market.

PETERBOROUGH ELECTRICITY WORKS.

The subject of electric lighting has been before the Corporation of the City of Peterborough since 1889, in which year two companies endeavoured, without success, to obtain powers. The same two companies renewed their efforts in the following year, and were joined by a third. This was too much for the City Council, which determined to oppose all comers, and in 1894 applied for and obtained a provisional order on its own account. In 1895 the Council instructed Mr. John C. Gill, the waterworks engineer, who had done the preliminary work in this connection, and Dr. J. A. Fleming, F.R.S., to jointly prepare plans and specifications for the purpose of carrying the order into effect.



Generating Plant.

The scheme drawn up by the engineers, provided for both public and private lighting, at an estimated cost of £20,000; the sanction of the Local Government Board to the raising of a loan to this amount was sought, and an official inquiry was held in 1896.

Strenuous opposition was met with, other municipal schemes being advocated as of more pressing importance, and there was but a bare majority of one vote on the Council in favour of the electricity undertaking; the result was that the Local Government Board refused its sanction to the loan, on the score of the money being wanted for sanitary improvements.

A second attempt was made in 1897, the public lighting being dropped and the scheme modified in various ways; an inquiry was held in 1898, but the Board still proved obdurate. At last, however, a deputation from the City Council succeeded in overcoming the scruples of the authorities, and sanction was accorded to a loan of £15,000.

During all this time there was no special Electricity Committee; but certain members of ths Council, notably Alderman Clifton, were indefatigable in their efforts to promote the scheme, and to defeat the aims of the private companies, with the success set forth above. Meantime, an important advantage resulted from the prolonged delay; thanks to the Board of Trade's assent to the use of higher pressures, it became possible to locate the generating station on a better site than the one first selected, albeit at a somewhat greater distance from the centre of the area of supply.

A plot of land (Albert Place Meadow), 3½ acres in extent, which belonged to the Council, and afforded exceptional facilities for the supply of water and fuel, being bounded on the south by the River Nene, and on the west by the main line of the Great Northern Railway Company, was chosen for the site of the works; unfortunately the soil was most unfavourable for foundations, and it was found necessary to excavate the whole site to a depth of 14 feet from the surface level, in order to lay bare a bed of gravel. As this was several feet below the level of the water in the river, the work was difficult and expensive, steam pumps being constantly at work to keep the water down. A massive foundation of arched concrete was then laid down over the whole area occupied by the present station buildings, 17 feet in depth, the surface being raised above the highest flood level. This work, which cost about £2,000, was carried out by Corporation workmen under the direction of the engineer, whose previous experience in this connection was of the greatest value.

The buildings were designed and the necessary plans and

specifications drawn up by Mr. J. C. Gill, and his chief assistant, Mr. C. R. Barlow, while Mr. E. W. Turner, now assistant engineer at the electricity works, also took part.

Station Buildings.

The contracts were allotted as follows :—

Buildings, Messrs. Main, Kendall & Main, Loughborough	£2,334	8	4
Boilers, Messrs. Edwin Danks & Co. (Oldbury), Limited	1,650	0	0
Pipes, tanks, condensers, &c., Messrs. Ashton, Frost & Co., Blackburn	1,700	0	0
Engines and dynamos, The General Electric Company, Limited, Manchester ...	1,952	0	0
Switchboard, Messrs. Crompton & Co., Ltd., Chelmsford	634	0	0
Accumulators, Messrs. Pritchetts & Gold, Feltham	849	0	0
Cables, Messrs. Callender's Cable and Construction Co., Limited, Erith	3,949	0	0
	£13,068	8	4

The erection of the works was begun on November 13th, 1899, and supply was commenced on December 19th last, to the general satisfaction of all concerned.

The buildings consist of boiler and engine rooms, battery room and engineer's office, with test room, workshop, pump-room, &c., attached. Ample provision is made for extensions, one end of the three rooms first named being composed of weather boarding, so that the whole station can be extended lengthwise without pulling down walls or interfering with supply in the least.

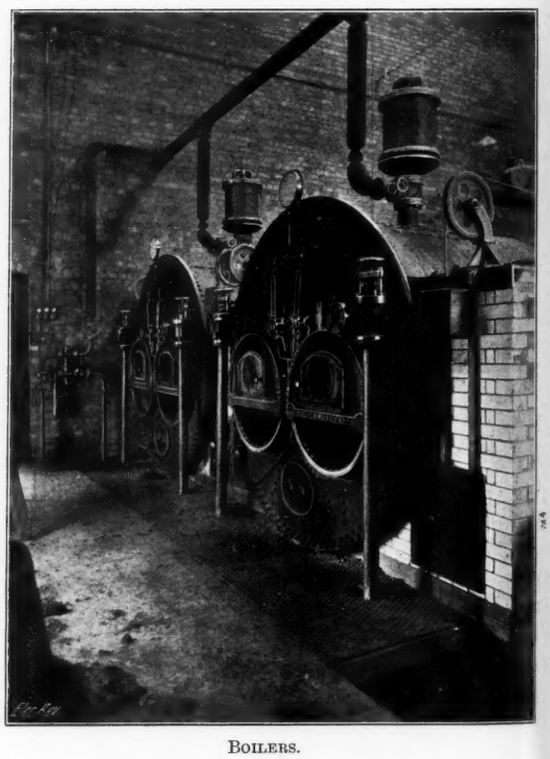
The boiler house is 33 feet long by 46½ feet wide, and is lighted from the roof; it provides accommodation for three Lancashire boilers, of which two, made by Messrs. Edwin Danks, are at present installed. Each boiler is 30 feet long and 7 feet in diameter, and is rated to evaporate 6,000 lbs. of water per hour, at a pressure of 160 lbs per square inch. The foundations are already laid outside the boiler house for three more boilers, making six in all. An economiser of Green's manufacture, with 96 tubes, is provided, with bye-pass flue; this will be increased in size as required without altering the flues. The scrapers are driven by a small steam engine; probably it would be more economical to use a motor for this purpose.

The chimney, as will be seen from our illustration, is of a somewhat novel and ornamental character; no doubt the designer had in mind the ancient cathedral of which the city is so justly proud, when he supplied it with a castellated capstone. It is 120 feet high from the ground level, and the foundations extend 17 feet 3 inches lower; the base is square for a height of 20 feet, after which the shape is octagonal. The internal diameter is 6 feet, and there is a firebrick lining to a height of 45 feet.

For the supply of coal a tramway is to be laid across the vacant ground to the embankment of the railway, where a tip will be made, so that coal can be unloaded from the railway wagons direct into small trucks and wheeled to the boiler house.

Feed and condensing water are derived from two wells, 18 feet deep; should these in course of time become inadequate to meet the increasing requirements of the station, a pipe will be laid to the river, through which water will flow by gravitation into the wells. A pit lined with cast-iron has been sunk in the pump room to a depth of 15 feet; at the bottom of this is a Tangye centrifugal pump, direct coupled to an enclosed waterproof motor of 12 H.P., made by Messrs. Ashton, Frost & Co., the contractors for this work. The pump is rated to deliver 42,000 gallons of water per hour to a height of 35 feet, for condensing purposes; and the delivery pipe is provided with a branch for the attachment of a second similar pump in the future. The delivery pipe is carried along inside the boiler house, and branches are taken through the wall to the ejector condensers in the engine room.

For feeding the boilers two pumps are provided, one driven by steam, the other by electricity. The former is a direct-acting duplex pump made by Messrs. Tangye; the latter is a three-throw plunger pump, driven through double reduction gearing by an enclosed four-pole motor, the whole being of Messrs. Ashton, Frost & Co.'s manufacture. The pinions are of raw hide, working into cast-iron gear wheels. A throw-over switch is provided, to enable the motor to be run at two speeds off either 460 or 230 volts, and rheostats of the G. E. Company's make are inserted in both the field and the armature circuit for further speed regulation. Each of the pumps is rated to deliver 18,000 lbs. of water per hour against the boiler pressure, and the piping is so arranged that either pump can be used for lifting water from one of the wells to a storage tank, or for forcing water from the tank or from the well into the boilers, through the economiser or direct, as



Boilers.

desired. The storage tank can also be filled from the town mains; it has a capacity of 3,000 gallons.

The steam piping is of steel, carried on brackets, and

forms a ring main, part in the engine room and part in the boiler house. It is sub-divided by valves between the branches to engines and boilers. The lagging is a patent composition of cork and charcoal, made by Messrs. Lonsdale and Co. Lancaster steam traps are used.

The engine room measures 37½ feet × 29½ feet wide at present, and is lighted from the roof and end wall. The generating plant consists of two sets of equal size, the engines being of Messrs. Willans & Robinson's standard 3Fs type, three-crank compound, and the dynamos of the General Electric Company's (Byng - Hawkins) manufacture.

The engines exhaust either to a common main beneath the floor, or to Ledward ejector condensers, one to each engine. The condensing water is led away to the river. A balanced automatic valve opens the exhaust to the atmosphere in case of accidental failure of the vacuum.

The dynamos are four-polar, and are rated to give 150 amperes at 400—460 volts, at a speed of 460 revolutions per minute; they are also guaranteed to stand an overload of 10 per cent. for four hours without injury. The magnet frames are divided on the horizontal plane; the field cores are cylindrical in cross-section, and are shunt wound. The armatures are barrel wound, with toothed cores. Carbon brushes are used, in four sets of six each, and the bearings are provided with ring lubrication.

The bedplate of the dynamo is combined in one casting with the bed of the engine, a rather unusual feature with multipolar machines; and there is a heavy fly-wheel combined with the coupling. The main terminal blocks are carried on studs screwed into the bedplate.

Space is available for two more generators in the present engine room.

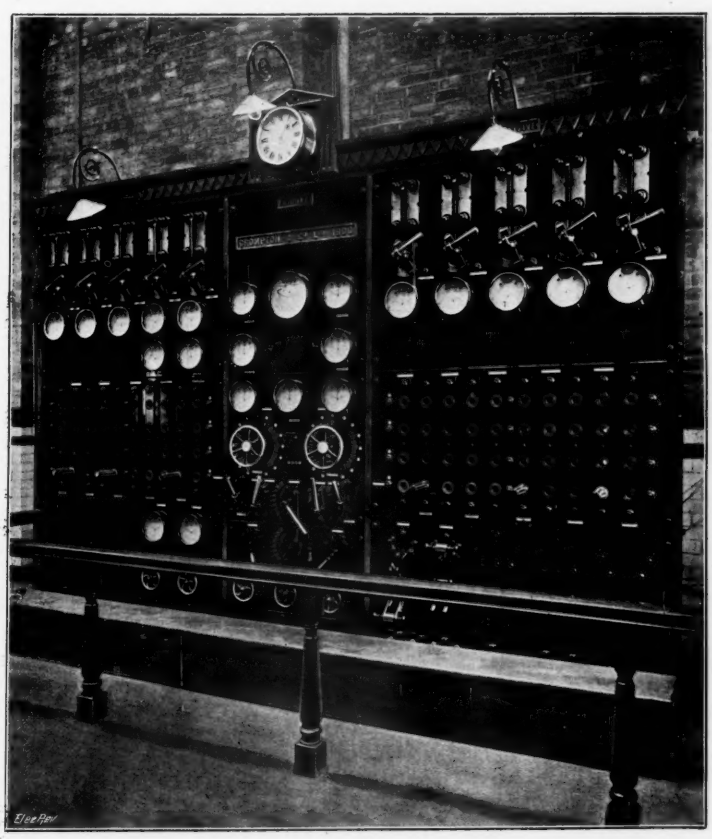
A combined balancer-booster set has been installed, which forms the subject of one of our views. This consists of two four-pole balancers, rated at 50 amperes 220 volts each, coupled together, and with two two-pole battery-charging boosters, rated at 60 amperes 80 volts each, the whole running at 970 revolutions per minute. The set was made by the General Electric Company, and forms a very neat combination.

The switchboard consists of three panels of enamelled slate, separated by strips of polished brass, and surmounted by ornamental iron work with a station clock in the centre. Provision is made for five feeders, five dynamos, and the battery and balancers. The board is of the plug-bar type, with four bus bars at the back. Each feeder is in circuit with a duplex fuse, and 300-ampere meter, and is joined to vertical bars; each dynamo with a zero current cut-out, 150-ampere meter, and fuses, and vertical plug-bars alternating with the feeder-bars. There are also two dynamo voltmeters reading between 380 and 480 volts.

The middle panel carries a main voltmeter of the same range, middle wire ± 150-ampere meter, ammeters for the balancer and battery circuits; and booster voltmeters; there are also two battery switches with 15 points for 28 regulating cells, and the necessary starting and regulating apparatus for the balancers and boosters. The board, as shown in our illustration, presents a handsome appearance; it was made by Messrs. Crompton & Co., Limited, the instruments being of the Crompton-Ashley moving coil dead-beat type.

The mains were laid throughout by the Callender Cable and Construction Company. The feeders, of which four sets are now in use, consist each of three cables, all of 0·25 square inch cross - section, insulated with bitumen, and laid solid in the same substance. A three-core pilot cable is brought back from each feeding point, and can be switched on to two large station voltmeters in the engine room.

The distributors are of the same type as the feeders, but are drawn into Callender-Webber casing with six ways, three of which are at present in use. The distributors are separate cables of 0·12, 0·06, and 0·12 square inch cross-section.



Main Switchboard.

The battery consists of 240 cells, capable of giving out 325 ampere-hours at a discharge rate of 36 amperes, and 240 ampere-hours at 60 amperes. The plates are contained in glass boxes, in two tiers, and were made by Messrs. Pritchetts and Gold.

Before the commencement of supply 2,300 8-c.p. lamps had been applied for, and connections are being made as quickly as possible. Ferranti ampere-hour meters are employed on consumers' premises, and electrical energy is charged for at the rate of 6d. per unit for lighting and 3d. for power.

Mr. John C. Gill, A.M.Inst.C.E., who is already the city waterworks engineer, has been appointed city electrical engineer; Mr. Jas. M'Kenna is resident engineer in charge of the works.

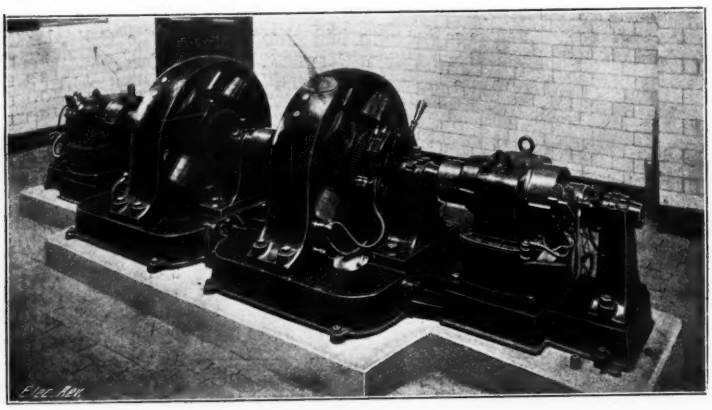
We are indebted to Mr. Gill for affording us facilities to obtain material for this article, and both to him and to his staff for their kind assistance in its preparation.

ECONOMIES IN THE INSTALLATION OF ELECTRIC TRAMWAY PLANT.

By W. H. BOOTH.

The Americans have recognised the practical and commercial meaning of the load factor of an electrical power station. By load factor, in this case, we refer, of course, to the ratio of the mean output of a station to the maximum load. As the writer has already pointed out, the load factor is dependent upon the number of divisions of which the load is made up, and the frequency of their starts and stops, as, for example, the cars of a tramway. For any particular

class of work, in which a general similarity of conditions prevails, it is probable that a simple expression could be found that would serve to express the load factor. Thus, in ordinary English tramway work, a fair approximation to the



Balancer-Booster Set.

load factor is found to be about $11\sqrt{c}$, where c is the average number of cars run every hour the line is at work, and is found by dividing the number of car-hours in a given time by the number of hours run by the station. There is nothing very scientific in this expression. It is purely empirical, and simply fits ordinary English conditions. Thus, if we suppose a system on which an average of 27 cars are always at work, the load factor will be practically 33 per cent. In other words, while a plant must be capable of doing a maximum duty of 100, its average duty will be 33 only.

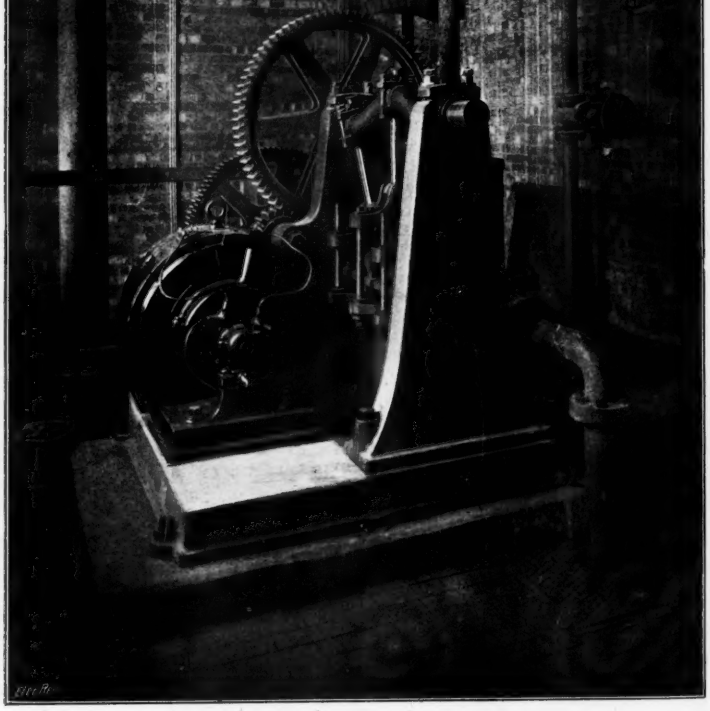
In designing a plant to give this output, the questions of initial and ultimate economy must be well considered. In the first place, the engine, or prime mover, is to be considered. The first point is that of condensing or noncondensing.

For an engine with a varying load it is necessary that the smallest engine be employed that will deal with the load, and, even then, the mean forward pressure will be too small for economy. In all cases where water is available for condensation, the economy due to condensing is practically beyond controversy, at least where intelligence and knowledge are allowed to direct matters. This is especially the case for small tramway systems, in which the application of condensing is sure to result in an economy of fuel such as will return 25 or 30 per cent., or more, on the investment. In addition to this, if condensing is provided from the start, the cost may largely be covered by the reduced cost of the smaller engines required. In this we do not even include the boilers; these may also be made 20 to 30 per cent. smaller. To neglect condensing is, in fact, a folly no engineer would commit, because by it not only are running costs reduced, but the capital account is kept smaller.

We may next consider the propriety of employing so-called higher classes of engines.

Compound engines are—very rightly—considered to afford economy on steady loads. But on a steady load the engine may be run at its most economical output. This cannot be done in traction work. The engine must be large enough to deal with its maximum load, and it follows that it must be much underloaded at its mean load.

From the very nature of the construction of a compound engine, it cannot deal with so large a maximum load as can a simple engine. Compound engines must thus be larger than simple engines that will deal with the same maximum loads. Doubtless, at the maximum load, the compound engine is the more economical, but periods of maximum duty are so brief and periods of small duty are so prolonged, that the simple engine secures the advantage at the mean load when load factors are small. Yet there are to be found traction stations with compound non-condensing engines, the money sunk in compounding being probably sufficient to go a long way towards providing the desirable condensing plant. In brief, the steam plant of a tramway station needs to be designed, so far as possible, with a view to its duty. A certain class of men who take a pride in their so-called business capacity will insist on reducing first cost by the elimination of all aids to economy. This is their idea of business acumen. At the same time they will allow their capital accounts to be swollen with heavy costs for engines



Electrically-Driven Pump.

of unnecessary and uneconomical size because there are so many precedents for this, and your man of business can never free himself from the trammels of the past. In America engineers are allowed to attend to matters of engineering to

a greater extent than is the case in England, and this may be one reason why traction matters make such comparatively poor progress in Great Britain.

A point in which American electrical manufacturers have scored great success is in the close designing of their traction generators. An American traction generator has just about sufficient copper in it to scrape through its test runs of six or eight hours without breakdown, but it has hardly enough to do so without suffering some injury which will ultimately be paid for by the user. The English machine will run the test with much less rise of temperature, and English makers pride themselves on their liberally-proportioned machines. But it may be considered but questionable wisdom to provide a 150-KW. generator to do work that is just within the compass of one of 100 KW. capacity. Let the subject be looked at from a purely practical point of view. The American machine scrapes through its full load test of eight hours. It is then put to regular traction work, and throughout its life is never called upon to do more than possibly 20, 30, or 40 per cent. of the above test load. Need any wonder be felt that the machine gives satisfaction and keeps cool, and can it be considered sound business engineering to put in a generator that runs cold at a full load that is three to five times larger than the mean working load ?

Recently such a cold running machine was tested by the writer on a full load, which was five times the customary average load. British makers should give attention to these points. Liberal proportions are very well and commendable, but there is a limit beyond which liberality becomes waste—waste of capital, to begin with ; waste of power constantly run away in driving a needlessly heavy machine. In advocating small engines of the simple type for duty affected by poor load factors, it must not be assumed that the working parts are to be small and light. These must be strong, because maximum boiler pressure will often be carried full stroke in the cylinder, whereas the steam stresses in compound engines are much lower and better distributed, this latter point not being of particular importance in traction work. Within reason, too, fly-wheels are to be kept fairly heavy, because a heavier fly-wheel enables the maximum load to be carried by a smaller engine. But this must not be carried to excess, because fly-wheels create bearing friction, and this is a continuous brake on the engine and absorbs power.

Practically it is desirable in small systems to seek out the smallest and simplest engine, and to provide for its most economical working by running it on a condenser with superheated steam from boilers fed through a flue-feed heater. The subject of superheat is mentioned, because by its means the usually accepted chief advantages of the compound over the simple engine are largely nullified, for it is from the cylinder effects of condensation on the initial steam entering the cylinder that the greatest economic loss in a steam engine arises.

Other things being equal, the fuel economy of an electrical tramway is proportionate inversely to the load factor, and most cases of large fuel consumption per unit, if thoroughly investigated, would probably be found to owe their troubles to poor load factors and machinery of excessive dimensions badly provided with aids to economy. In the first years of the new century there will be a very large amount of either public or private capital invested in tramway undertakings. At this moment the prospects are all in favour of the supersession of private by municipal enterprise, and there is not much to choose between the two as regards results. Success will undoubtedly range itself upon the side of the best engineered schemes. In this respect both public and private enterprise may be said to stand on an equal footing in that they are free to employ the best engineers they care to pay for. The members of city councils are largely tradesmen, and unless they allow themselves to be guided by their engineers they may land themselves in a very awkward fix should they waste public money by neglecting their advice. Private enterprise, on the other hand, may be in the hands of good men of business, or it may be directed by men of no business ability, or, while the general direction may be good, the details may be controlled by non-technical men, who hardly know a condensing engine when they see one, think it waste to put down economisers, and yet are so tied to precedent, that while shouting for small capital expenditure, they will spend thousands on monster chimneys rather than follow their engineer's advice to use mechanical draught at the expense of hundreds only. Thus the municipalities are compulsorily better situated to command success than are private enterprises, unless these are well directed. The success of Americans and of Germans seems to be largely due to the much greater freedom allowed to engineers, indeed, to the expectation of financial men that their engineers shall be well paid and must be obeyed in all things technical.

Every financial manager abroad does not fancy himself a better engineer than men who have devoted their whole lives to engineering. If English trade in the new century is to hold its own, the same recognition of technical knowledge will have to be given to its holders as is given in Germany. Amateur engineers of one year's *study* must stand aside.

FORTHCOMING EVENTS.

Friday, January 18th.—At 9 o'clock. Royal Institution. Prof. Dewar, M.A., LL.D., F.R.S., M.R.I., on "Gases at the Beginning and End of the Century."

Wednesday, January 23rd.—At 7.30 p.m. Institution of Electrical Engineers (Students' Section). Papers to be read:—"Electro-Chemical Exhibits at the Paris Exhibition," by M. Solomon; "Accumulators at the Paris Exhibition," by J. H. West.

At 8 p.m. Society of Arts. Seventh ordinary meeting; paper on "The Proposed High Speed Electrical 'Monorail' between Liverpool and Manchester," by F. B. Behr. Sir William Preece, K.C.B., F.R.S., will preside.

Thursday, January 24th.—At 8 p.m. The Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers, 25, Great George Street, S.W. "Capacity in Alternate Current Working," by W. M. Mordey, Member. Adjourned discussion.

At 7.30 p.m. Institution of Electrical Engineers (Dublin Section). Meeting at the Royal Dublin Society.

Friday, January 25th.—At 8 p.m. Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "Railway Construction," by Mr. Alexander Ross, M.Inst.C.E., Engineer to the Great Northern Railway.

At 5 p.m. Physical Society. Meeting at the rooms of the Chemical Society. Paper on "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker.

At 8 p.m.—Electro-Harmonic Society at St. James's Hall Restaurant.

Saturday, January 26th.—The Institution of Electrical Engineers (Students' Section). Visit to the works of the India-rubber, Gutta-percha, and Telegraph Works, Company, Limited, Silvertown.

At 7 p.m. Institution of Junior Engineers. Anniversary dinner at the Westminster Palace Hotel.

NOTES.

Erratum.—In our article on "The Nernst Imbroglio," page 98, 14 lines from the end, for "the company's meeting next week" read the company's meeting to-day.

The Resurrection of a Cat.—Some of the London papers have been making a fuss about a Chicago electrician who, having killed a cat by electric shock, brought it back to life again by the same means. We don't see anything remarkable about this, for a cat has nine lives, and it would have returned to life in the ordinary course without the intervention of this "eminent electrician." We don't know that the present alleged finding is altogether a matter for rejoicing. We've vowed vengeance upon many a London feline offender ; we shouldn't like to think that their return to life was to be unduly hastened.

Electrolytic Manufacture of Caustic Soda.—We learn from our Niagara Falls correspondent that the new plant of the Acker Process Company, of Niagara Falls, has commenced operations. The product of this new factory will be caustic soda and bleaching powder, and the manufacturers of these articles, both in Europe and the United States, are materially interested in the results hoped to be obtained from the plant by the process to be used. It is understood that this is the first plant built to develop the Acker process, and it has been emphatically stated that the work that will be accomplished under the patents held by the company will have a very marked effect upon the chemical world. The power used in the factory is supplied by the Niagara Falls Hydraulic Power and Manufacturing Company. This power is supplied in the form of direct current of over 8,000 amperes and at a voltage of 300. The current is used in a single series of decomposers, and it is said that it is quite 15 times greater than that thus far used in any plant having a similar product for its output in the United States or Europe. Just here comes in the very important feature of the plant, for as the current is 15 times greater, so is the output capacity of the plant expected to be 15 times greater. This means that each decomposer in which the current is applied according to the Acker process will have about 15 times the output capacity of any similar apparatus used up to this time. In other words, similar apparatus having about the same dimensions, will turn out only about one-fifteenth of the Acker machines with the same use of electric current. It will be seen from this that if the new plant demonstrates the efficiency claimed for it, it will naturally have a notable effect on the market price of the commodity. The efficiency of the apparatus and the fact that an electric current of such volume can be operated successfully in the space required, are alleged to be due to the employment of a molten electrolyte in place of the solution employed in other plants. It is a well-established fact that the conductivity of a molten salt bath is very great as compared with brine, and this is true whether or not the latter is heated. In the molten salt no secondary reactions are possible owing to the fact that no water is present. In the process that will be used by the Acker Company, the electrolyte is maintained in a molten condition by the electric current that decomposes it, and for this reason the electromotive force required is somewhat higher than where brine is decomposed. It is generally understood that in all the processes used there is the necessity of boiling down the caustic soda, but in the Acker process it will be in a condition ready for being put in packages, and this fact will more than counterbalance the expense attached to the increased voltage used. It is further stated by one who is in a position to know that the finishing of each ton of caustic soda by the old process requires nearly three tons of coal, an expense that is entirely saved by the new process. In the Acker process the chlorine gas is given off much the same as in the old method, but it is dry, a feature of some little value, as in making bleaching powder or chloride of lime, the gas has to be absorbed by the lime. Only recently the price of bleaching powder has been advanced about $7 a ton, owing to the increased consumption in various fields where it is used. The greater part used in the United States is imported from Europe, but in the increasing use of the electric current at Niagara Falls, there is every prospect that the output will be increased each year at that point.

Harnessing Niagara.—An interesting and chatty article appears in the current issue of *Cassell's Magazine*, from the pen of Miss Gertrude M. Bacon, under the above title, though it really embraces a vivid description of the natural beauties and marvels of the Falls themselves as well as of the wonderful works erected there by the hand of man. Considering that the writer is a woman, not specially versed in technical matters, the description of the power house is "not half bad," the only notable slips being the use of such expressions as "a current of 40,000 volts, representing a horse-power of 35,000," which, we are told, was sent through letters made of strips of tinfoil spaced out on a sheet of glass in the "Thunder and Lightning room," set apart apparently for the purpose of instilling awe into visitors!

Electricity in Machine Tool Works.—The well-known firm of Messrs. Geo. Richards & Co., Limited, machine tool makers, Broadheath, near Manchester, have just completed some important alterations by which almost the whole of their system of power has been converted from steam to gas. The principal reason for the change arose in consequence of the uncertainty of the local water company being able to continue a regular and constant supply of water. The fear of a stoppage led the firm to consider how the difficulty could best be met, and it was wisely determined to enter upon a scheme of reconstruction. A new gas generating plant of 320 H.P. has been erected by the Dowson Economic Gas Power Company, Limited. This is in every respect a compact and efficient plant, and so far as it has been tested, the results have been found as satisfactory as could be wished. Four new gas engines, by Andrews, of Stockport, have been put down. The largest is one of 100 B.H.P., which drives a dynamo from which the power is transmitted to six electric motors in all parts of the spacious machine tool department. The second engine is one of 80 B.H.P., and it will be used exclusively for driving the pulley shop. A third engine of 42 B.H.P. will provide the necessary power for the heavy erecting and testing shop, while a separate one of 26 B.H.P. will drive the machinery used in connection with the foundry. The directors do not propose to dispense with the use of steam entirely. One steam boiler of 100-H.P. will be retained for the engine driving the dynamo which supplies the current for general lighting. The exhaust steam is utilised in winter for heating the large workshops and offices. Altogether some 800 lamps are required in the establishment, where between 400 and 500 hands are constantly employed. The two dynamos mentioned were made by Royce, Limited, of Manchester. The lighting and power switchboards have been supplied and erected by Cowans, Limited, of Manchester. The whole of the alterations have been carried out at a cost of about £4,000, and their importance will be seen when it is stated that the directors expect to effect a saving in the working expenses of £1,000 annually. The firm has just ordered a 5-ton electric crane from Berry, of Swinton, for use in the foundry.

Wanted, £10,000.—The following piece of unconscious humour comes to us from an eastern counties correspondent. The writer of this postcard does not say whether his name is to be published or not; we have, however, taken upon ourselves to suppress it. At the same time, we have no doubt there will be a rush of generous donors anxious to find £10,000 capital and to pay for a front-page advertisement, so as to help our "energetic and smart man" out of his present dilemma:—

> Would you promise support by front-page advertisement?
>
> 13—1—'01.
>
> Dear Sir,—Will you kindly inform me what conditions are to be complied with in the formation of a new company, and whether it is *legal* for a man without capital to start a company by first advertising and obtaining, say, £10,000 in £1 shares; if so, do you consider it risky for an energetic and smart man to try?—I am yours, &c.

Personally we do not feel inclined to invest, but it is said "fools rush in where angels fear to tread," and for the benefit of such we would add that all cheques should be duly crossed and addressed to "Smart Man," care of ELECTRICAL REVIEW.

Inverted "Ark" Lamps.—Messrs. Johnson & Phillips send us a descriptive sheet of an inverted enclosed, long-burning "Ark" lamp recently introduced by them. The principal points worthy of notice are that the lamp is short in length and of pleasing design, and is claimed to possess all the features of long-burning, simplicity and durability common to the makers' ordinary "Ark" lamps. It will burn on any circuit, and is supplied with internal resistance or choking coil. The ordinary "Ark" lamp can be altered to an inverted type by simply removing the outer globe and substituting the inverted reflector. It is believed that this is the first time that an inverted lamp has been made on the "enclosed" principle.

Corporations and Contracts.—An animated correspondence took place last month between Messrs. Williamson and Joseph, Limited, and Mr. Charles Furness, borough electrical engineer to the Devonport Town Council. The point at issue was the award of a contract for a switchboard which was allotted to the E.C.C. at £2,922. Messrs. Williamson and Joseph tendered much lower, and claimed that their tender conformed to the specifications in every particular; naturally, therefore, they inquired why they had been passed over. Mr. Furness, in reply, stated that he did not agree as to conformity, and pointed out that certain deductions had to be made from the E.C.C.'s tender, which brought down the sum considerably. The E.C.C. were also successful in tendering for the generators and the electrical equipment. Messrs. Williamson, in their rejoinder, traversed Mr. Furness's objections, and urged that it would have been much better if the Corporation had placed the order with the E.C.C. or any other firm, without troubling a large number of firms to prepare tenders at considerable expense and trouble. There were other tenderers who quoted lower than either Messrs. Williamson & Joseph or the E.C.C., and the former averred that they did not complain of the contract being awarded to another firm, but of the unfair treatment which they said they had experienced. As both parties indulged somewhat in personalities, it would not be profitable to publish the letters *in extenso*, but the above summary gives the gist of the correspondence. It is difficult, on scanty information, to form an opinion as to the merits of the case, and we prefer to leave the matter to our readers; many such incidents must have taken place from time to time, and we should be pleased to receive correspondence dealing with this subject.

Postal Telegraph Clerks' Soirée.—The London Branch of the Postal Telegraph Clerks' Association announce that at their annual soirée and Bohemian concert, which will be held at the Holborn Town Hall on February 1st, Signor Marconi will in person conduct a demonstration of his system of wireless telegraphy. The experiments will include the use of all the latest forms of apparatus now employed by the inventor. Tickets can be obtained from the secretary, Mr. Chas. H. Garland, of the Central Telegraph Office, London, E.C.

Sydenham Boiler Explosion.—The report of the Board of Trade upon the boiler explosion which occurred last July at the works of the Crystal Palace District Electric Supply Company, in which two persons were killed and five injured, is printed in the *Times* for January 14th. The boiler was a nine-year-old Hornsby, and the crown of the fire-box was blown off bodily, the explosion being due to over-pressure of steam. We make the following extracts :—

> The boiler was not properly or thoroughly examined by Mr. Charles A. Booth, an inspector of the Engine Boiler and Employers' Liability Insurance Company, on April 17th, for he did not gauge the fire-box. The boiler was not then fit for a safe working pressure of 140 lbs. per square inch. In our judgment proper measures were not taken by the Crystal Palace Company to ensure that the boiler was being worked under safe conditions. With the exception of the inspectors of the insurance companies the persons who were employed to examine the boiler were not competent to do so, and Mr. Phillips, the electrical engineer of the company, was not competent to ascertain whether they knew their duties or to supervise their work. We do not, however, consider the faulty construction the real or immediate cause of the explosion. . . . . The explosion was caused by the neglect of Mr. Phillips. He knew there was deflection in the fire-box crown, and, not being able to ascertain the cause of it himself, he wrote to the National Boiler Insurance Company to advise him. The advice he received was to have the boiler tested by hydraulic pressure to 280 lbs. per square inch. For the application of this test Mr. Phillips failed to make arrangements at the time, and the importance of it never seems afterwards to have occurred to him. . . . . This neglect, we find, was the main cause of the explosion, for which we find Mr. Phillips to blame, and for which we must hold the Crystal Palace Company responsible.

Appointments Vacant.—An assistant electrical engineer at £104 per annum is wanted for Doncaster; a chief assistant at £130 per annum for Devonport; and a chief assistant at £2 2s. per week for Keighley. An electrical engineer is wanted for Paisley at £250 per annum with house, &c. The Fulham Borough Council wants an assistant electrical engineer. See "Official Notices."

Personal.—Mr. W. A Dyer has been appointed as chief assistant to Mr. D. F. Adamson, the electrical engineer to the Corporation of Southend-on-Sea. There were 27 applicants for the post.

Mr. Arthur H. Shaw, of Harrow, has been appointed resident electrical engineer to the Ilford Urban Council.

Mr. Andrew Stewart, of Messrs. Walter Dixon & Co., electric power engineers, Glasgow, has been appointed manager and engineer to the County of Durham Electric Power Distribution Company, Limited. He takes up his new duties at Gateshead early in February.

Mr. L. R. Lee has just been appointed mains engineer to the Manchester Corporation Electricity Department, at £300 per annum, in place of Mr. F. E. Procter, who resigned at Christmas.

Mr. Charles A. Maby, of Bristol Electricity Department, has been selected from between 200 and 300 applicants for the post of secretary to the Bromley (Kent) Electric Light and Power Company, Limited.

Mr. A. P. Dryburgh, of Doncaster electricity works, has been appointed assistant electrical engineer at Grimsby.

The Electric Light Committee of the Salford Corporation recommends the Council to appoint Mr. Charles D. Taite, of Southport, as electrical engineer at a salary of £700 per annum. There were 35 applicants for the position. Mr. Taite, who succeeds Mr. Turner, who resigned some time ago, has been electrical engineer of Southport for about five years.

Obituary.—MR. C. E. GROVE.—It falls to us as a very sad duty this week to record the death of Mr. C. E. Grove at the early age of 37. Last week we ventured to hope that he would have a speedy recovery, but we learn with the deepest regret that he passed away on Friday, the very day upon which our last impression appeared. Mr. Grove entered the Post Office service in 1881, and was engaged from that year up to 1888 in the Receiver and Accountant-General's department. In 1888 he was transferred to the engineer-in-chief's office, where he did excellent work, especially in connection with the extensive machinery plant used for pneumatic tube working, both in London and the provincial towns. Mr. Grove left the Post Office service in 1892, and joined the Thames Ironworks Company as their electrician. With this company he remained until the day of his death. It may be remembered that Mr. Grove recently took the £25 prize for the best paper read before the Institution of Electrical Engineers. Many also have met him at the meetings of the Electro-Harmonic Society, of which he took up the honorary secretaryship about two years ago. At the smoking concert of this Society next Friday, Chopin's "Marche Funèbre" will be performed at the commencement of the evening by a small string and wind orchestra as a mark of respect to his memory. We beg to tender our expressions of heartfelt sympathy with the remaining relatives of the deceased gentleman.

Lectures.—Dr. Fleming is to deliver an address on "Wireless Telegraphy" before the Liverpool Chamber of Commerce on February 5th.

Mr. Hy. W. Ravenshaw (London) gave a lecture on "Sparking in Dynamos" on Monday evening at the Leeds Yorkshire College, in connection with the College Engineering Society. The President of the Society is Mr. Wilson Hartnell.

Mr. Thwaite, as Vice-President of the Society of Yorkshiremen in London, has promised to address the Society in March on "Michael Faraday," who was of racial descent on both sides a Yorkshireman.

The Cauvery Falls.—An Indian newspaper has the following paragraph :—

> The Cauvery Falls project is making rapid progress. Captain and Mrs. Lotbiniere have returned from America, for it is from America, as usual, that we have received the greater parts of the machinery. Switzerland also is sending its quota, and it is sad that England and English work should be again distanced by foreign competition. Three American engineers have also arrived. Their headquarters will be Bangalore, and a little leaven of the American girl ought to make things merry a bit in the station.

Are American girls an item to be considered in meeting American competition?

Depilation by High-Tension Electric Currents.—At a recent meeting of the Vienna Society of Physicians, Dr. Schiff and Dr. Freund reported an interesting action of high-tension currents on the skin. According to the authors (says the *Lancet*), when the hairy skin is exposed for 20 minutes to the silent discharge of the negative pole of a powerful Ruhmkorff coil, such as is used for the production of the Röntgen rays, the hairs commence to fall out, the hair-bulbs become atrophied after the third exposure, and some days later the portion of the skin which had been exposed becomes perfectly bald. The hair follicles become red and inflamed after the first two exposures. These observations seem to prove that depilation can be produced by the action of high-tension currents, and that the depilatory effect of exposure to the Röntgen rays may be accounted for in this way.

Damages for Slander.—The slander action set on foot by Mr. Francis Teague, the Paisley electrical engineer, has now been heard at Edinburgh, with the result that Mr. Teague secured a verdict for £100 damages against Dr. Wm. Russell, a member of the Paisley Electric Lighting Committee, for statements made at a committee meeting in September, 1899, to the effect that he was using his official position as a means of compelling people to buy certain lamps. We congratulate Mr. Teague on the result of the action, and we venture to hope that one effect of the decision will be to place a bridle upon the tongues of councillors and committeemen, who too often seem to deem it their special prerogative to say whatever they like about their engineers. If electrical engineers were allowed a voice at Council meetings they would be less abused. We learn that Mr. Teague has given notice of his resignation of office, which will take effect on February 28th.

The Municipal Contracts Question.—The municipal contracts question, as affecting private firms which carry out contracts with a town council, and are, at the same time, identified with it by membership, has just had a singular development in Bolton. Although a local one, the matter is of interest to all heads of engineering and electrical limited companies. It has arisen in connection with the resignation of Mr. W. M. Musgrave, J.P., as a member of the Bolton Town Council, in which public office he has been rendering valuable service to the borough as chairman of the Technical Instruction Committee. Mr. Musgrave is the principal of the firm of Messrs. Musgrave & Sons, Globe Ironworks, Bolton, and during the recent municipal contracts agitation he was named as having, through his firm, had business relations with the Corporation with regard to the electrical engineering plant required by public undertakings. It was pointed out that Mr. Musgrave had on no occasion exercised influence in any way, having, in point of fact, sedulously refrained from identifying himself with decisions as to contracts. Nevertheless, there was a considerable amount of annoying and somewhat pettifogging criticism which led the heads of departments and the foremen of the firm of Musgrave & Sons to approach Mr. Musgrave and urge upon him to no longer make the sacrifices he was doing, and evidently unappreciated as they were in some quarters, at the cost of this most unfair criticism. They pointed out that the firm would be the gainer if he relinquished his municipal duties, and once again devoted all his time to his ordinary business. Mr. Musgrave, after considering both aspects of the matter, has now resigned, with the intimation that he cannot reconsider that decision. So far from his connection with the Council helping his firm, it has been an unfair handicap. He was willing to bear that, but when there came the criticisms which have been recently indulged in, the state of things became such that it was not to be tolerated. This action of Mr. Musgrave, who is one of the most prominent and most highly respected citizens of Bolton, has aroused much comment in the town, and there is some curiosity as to what further developments may arise, as other members of the Town Council are similarly affected.

Punkah Pulling.—Electricity is to be tried forthwith on a large scale for pulling punkahs in the Simla Military Barracks. The first station to be taken in hand is Bareilly, and Hoare's system is to be adopted. A central station with the necessary engines, boilers, and dynamos is to be erected in the centre of the cantonment, and it is expected that the installation will be in working order by next hot weather. A lakh of rupees is to be expended. The contract referred to has been obtained by Messrs. Turner, Hoare and Co., who are the local agents in Bombay for Messrs. Siemens Bros. & Co. The principle on which the punkahs are pulled is new, being simply that an electric motor drives an endless band which drives all the punkahs in one barrack. The ordinary swinging punkahs are thus utilised.

Institution of Naval Officers Afloat.—We learn that the Admiralty have decided upon a new system of instruction for junior officers afloat, which should be a great improvement on the old methods. Hitherto it has been customary for the midshipmen to devote a few hours in each week to the study of gunnery, steam and torpedoes, the rest of their time being divided between mathematics (of which problems in navigation formed the chief item) and seamanship. Now, however, regular courses of a fortnight or so at a time will be undergone, during which they will give their attention to one particular subject, and an examination will be held at the end of each course to test their efficiency. In these days when mechanics and electricity have come so much to the front in modern warfare, it is in the highest degree desirable that officers should get an early grounding in these subjects, but the tendency has been rather to regard them as outside the province of a sailor's profession. Seamanship and the handling of masts and sails has been always looked upon as the most important part of an officer's training, and rightly so as long as the ship depended upon such motive power; but now such knowledge plays a very unimportant part in the duties of a naval officer; in fact, seamanship, in the sense in which it is generally understood, is practically obsolete now. To devote an hour or so each week to a subject is to do no more than play with it, and it is by this system of mixing up the various branches together that we get such startling effects as were illustrated by the midshipman who, in an examination on steam, announced that the "pitch of a screw" was "3·1416, and made of cast-iron."

Getting Up-to-Date.—As a sign of the progress of some of the old-established firms in this country, we are pleased to hear that Messrs. J. & F. Howard, of Bedford, the world-renowned agricultural implement makers, have determined to remodel the whole of their works. This is largely due to the recent visit to America of one of the partners, Mr. Harold Howard, since which time great changes in the system of manufacture have been introduced; and to enable them to adapt the entire works to the altered conditions of the times, the firm have arranged for taking out the whole of their present system of driving and putting in a complete system of electric transmission with the most economical form of generating plant and motors on the continuous current system. The contract has been given to Messrs. W. H. Allen, Son & Co., Limited, electrical engineers, of the same town.

Institution of Electrical Engineers.—The officers of the Birmingham Local Section for the current year are as follows:—*Chairman:* Oliver J. Lodge, D.Sc., F.R.S.; *Vice-Chairman:* Henry Lea, M.Inst.C.E.; *Committee:* F. Brown, Alfred Coleman, Alfred Dickinson, A.M.Inst.C.E., G. S. Ram, W. E. Sumpner, D.Sc., Prof. R. Threlfall, A.M.Inst.C.E., W. Wyld, J. C. Vaudrey, M.Inst.C.E.; and *Hon. Secretary:* D. K. Morris. The inaugural meeting, as already stated, will take place on Wednesday, January 23rd, at 8 p.m., in the buildings of the University, Edmund Street (by permission of the University Council), when the chairman of the section, Dr. Oliver J. Lodge, F.R.S., will deliver an inaugural address. Prof. Perry and Mr. McMillan have accepted invitations to be present. The address of the local hon. sec. is at the University, Birmingham.

Ancient History.—M. Maiche, a well-known French electrician, has just constructed (says the *Daily Telegraph*) the first wireless telephone. He tried the invention successfully two days ago in the woods of Saint Germain. The transmitting apparatus was placed in a house on the outskirts of the forest. It communicated with the earth by means of a metallic cable, described as similar to the chain of a lightning conductor, which was driven a certain depth in the ground. About half a mile away in the woods two iron posts, connected by a conducting wire, were planted in the ground, 90 feet apart, a damp spot being preferably chosen. To one of these posts was attached an ordinary telephone receiver. The voice of a man speaking into the transmitting apparatus at the house was then distinctly heard. The ticking sound of a special instrument, consisting of a clockwork train moving a needle which struck a bath of mercury, was also clearly perceived. M. Maiche has not disclosed the secret of his invention. He states, however, that the communication in his wireless telephone is established, not as in the case of the Marconi wireless telegraph by a wave current, but by a circuit current. As yet M. Maiche has not been able to transmit messages over a distance of more than 1,000 or 1,200 metres, but his experiments have proved that the principle of the wireless telephone is now an established fact. M. Maiche and the *Daily Telegraph* are apparently ignorant of the fact that a wireless telephone system, designed by the Postal Telegraph Department, has been daily at work for the last seven months between Holyhead and the Skerries, a distance of 5 miles, so the "established fact" is comparatively ancient history. Does the *D.T.* know that Queen Anne is dead?

The Röntgen Society.—The Council announce that the President has placed at their disposal a gold medal to be awarded to the maker of the best practical X ray tube for both photographic and screen work. The competition is open to makers in any country. Tubes intended for competition must be sent in addressed to the Röntgen Society, 20, Hanover Square, London, W.

Monument to Lindsay.—The people of Dundee are hoping to erect a suitable monument at the grave of James Bowman Lindsay, "the first inventor of wireless telegraphy," in the Western Cemetery. £25 has been subscribed, and a further £75 is required. Subscriptions should be sent to Mr. A. H. Millar, *Dundee Advertiser* Office, Dundee.

Electric Motor Carts.—The borough surveyor of Fulham, after due investigation, advises the Council not to adopt electric motors for cartage purposes. The great expense is the ground of objection. The price quoted to him by one firm was £750 for a motor cart capable of carrying 1 ton at eight miles an hour.

NEW COMPANIES REGISTERED.

Fermoy and District Electricity Company, Limited (68,879).—This company was registered on December 28th, with a capital of £7,500 in £1 shares (3,000 preference), to supply electricity in Fermoy, co. Cork, and the surrounding district, and to carry on the business of electricians, electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—W. Fennell, 8, Ferndale Road, Leytonstone, electrical engineer; C. J. Inder, 5, Albion Square, Dalston, N.E., electrical engineer; W. W. Norman, Essendene, Chobham Road, Woking, secretary; F. J. Warden-Stevens, The Mount, Leatherhead, Surrey, engineer; H. Briff, 196, Bedford Hill, Balham, S.W., electrician; Mrs. J. Spring, 52, Anson Road, N.; and A. C. Hertel, 34, Francis Road, Leyton, clerk. Table "A" mainly applies.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Mackey's Electric Lamp Company, Limited (58,437).—This company's annual return was filed on January 3rd, when the entire capital of £2,000 in £1 shares had been taken up. £1 has been called up on each of seven shares, and £1,993 is considered as paid on the remainder.

Cape Electric Tramways, Limited (54,636).—This company's annual return was filed on November 28th, 1900, when 400,000 shares were taken up out of a nominal capital of £500,000 in £1 shares. The 400,000 shares are all considered as fully paid. Notice of allotment of 70 shares (payable in cash) has since been filed.

SUPPLY STATION ACCOUNTS.

Ealing District Council Electricity Accounts.

In the report attached to the 1897 accounts of the Ealing Urban District Council's electricity supply undertaking, it was stated that some £4,000 of the capital expended on new buildings was unproductive and unremunerative. A similar remark might, we imagine, be made regarding at least some of the £22,475 which appears as additional expenditure on capital account during 1899. As will be seen below, the effect of increased charges in the net revenue or profit and loss account has been to reverse the sign against the net profit and to cause an apparent backward tendency. Yet a great deal too much can be made of this, for many stations will show somewhat similar peculiarities in accounts as large extensions are undertaken. Owing to contractors' delays and other causes tending to hold back the beneficial use of plant, and due to legislative requirements, it is often found that large sums of money are required to pay interest upon and sinking fund towards capital amounts expended on plant, long before that plant is actually completed and in a position to earn a return or create revenue.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£77,177	**£99,652**	£22,475
Number of units sold	445,241	**564,989**	119,748
Maximum load in KW.	302	**440**	138
Number of lamps connected ...	22,288	**31,762**	9,474
Gross revenue	£8,830	**£11,012**	£2,182
Gross expenditure...	£5,207	**£6,239**	£1,032
Gross profit	£3,623	**£4,773**	£1,150
Average price per unit sold ...	4·55d.	**4·56d.**	+·01d.

The output has been pushed beyond the half million unit mark, and for a residential district, the ratio between maximum load and output is favourable. About half the increase in gross revenue is absorbed by additional expenditure, the other moiety goes to swell the gross profit. The average price received for energy is practically unaltered, but owing to the form of the accounts, and the disappearance of "deposits" and "sales" which together represent over $\frac{1}{10}$d., the return per unit from all sources has apparently dropped ·08d. The capacity of plant installed at the end of 1899 was 458 KW., and the rates charged were 6d., 5d., 4½d., and 3d. per unit, having regard to the class of consumer, and 3d. for "power and heating." There are 75 11-ampere public arc lamps, and 891 8-C.P. incandescent lamps in use.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase
Sale of energy	£8,447	4·55d.	**£10,736**	4·56d.	+·01d.
Meter rents	188	·10d.	**270**	·12d.	+·02d.
Sale of apparatus, &c... ..	87	·05d.	**3**	·00d.	−·05d.
Sundry fees and deposits ..	108	·06d.	**3**	·00d.	−·06d.
Gross revenue ...	£8,830	4·76d.	**£11,012**	4·68d.	−·08d.

In the costs, coal shows an increase, but this is exactly balanced by a fall in oil and engine-room stores. The charges incurred in maintaining the public lamps are distributed between wages and repairs. Taking these two items together, we get a drop of about ½d., which appears therefore as the change in works costs. Salaries and establishment charges remain unaltered, while small negative alterations are shown in rent, rates, &c., and in other expenses, the latter being clear in 1899 owing to deposits being eliminated from the accounts. The result is a reduction of ·16d. in total costs (now 2¾d.), upon which Mr. J. Douglas Knight must be congratulated.

Cost of Production.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Coal	£1,957	1·06d.	£2,672	1·13d.	+·07d.
Oil, waste, water and engine room stores	305	·16d.	217	·09d.	−·07d.
Salaries and wages incurred in generation and distribution and attendance public lamps	1,246	·67d.	1,756	·75d.	+·08d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., including street lamps	738	·40d.	468	·20d.	−·20d.
Works cost ...	£4,246	2·29d.	£5,113	2·17d.	−·12d.
Rent, rates and taxes ..	266	·14d.	295	·13d.	−·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	529	·29d.	679	·29d.	−·00d.
General establishment charges, stationery and printing, law charges and insurance	107	·06d.	152	·06d.	·00d.
Other expenses: Deposits returned	59	·03	—	—	−·03d.
Total costs ...	£5,207	2·81d.	£6,239	2·65d.	−·16d.

When we come to finance it is seen that, owing to the gross profit being only greater by £1,150, while interest, &c., took £1,857, the difference of £707 has absorbed all the net profit of 1898 and leaves a net loss of £642. This represents ·27d. per unit, and should be wiped out by the increased profits from the plant covered by the capital expenditure which has given rise to these heavier financial charges. An increase in gross profit of about 30 per cent. is a sign that the net loss is not a serious matter.

Profit Statement.

	1898.	1899.
Interest on loans	£1,920	£2,675
Sinking fund for repayments	1,638	2,740
Net profit	65	− 642
Gross profit	£3,623	£4,773

Blackburn Corporation Electricity Accounts.

The accounts of the electricity undertaking of the Blackburn Corporation possess two features which mutually affect one another. In 1899 for the first time appears the sale of energy to the tramways, and while in 1898 the net result of the year's working was a loss, the succeeding year showed a small profit. Mr. A. S. Giles, the engineer of the electricity and tramway departments, has received a well-merited recognition of his services at the hands of the Corporation. The figures show rapid progress and a most moderate capital expenditure of under £100,000, with an output of over three-quarters of a million units. The average price per unit sold is low, at under 3½d.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£81,436	£98,334	£16,898
Number of units sold	368,087	755,661	387,574
Number of lamps connected ...	30,450	46,000	15,550
Maximum load in KW.	560	749	189
Gross revenue	£7,113	£11,821	£4,708
Gross expenditure	£4,166	£7,113	£2,947
Gross profit	£2,947	£4,708	£1,761
Average price per unit sold ...	4·05d.	3·41d.	−·64d.

The allocation of output is as follows:—

Year.	Units generated.	Private consumers.	Traction.	Public lighting.	Number of street lamps.
1898 ...	470,716	297,963	—	70,124	74 arcs and 34
		£5,141		£1,078	incandescents.
1899 ...	1,024,322	371,055	247,311	137,295	80 arcs and 248
		£7,202	£2,576	£992	incandescents.

The public arc lamps are of 8·3 amperes alternating and 10 amperes continuous current. The plant installed was respectively for the two years 915 and 1,615 KW. The scale of charges was 6d. and 3d. for lighting, and 2½d. and 1½d. for power. On sales of energy there is a drop of nearly ⅝d. per unit. This taken with the slight changes in the other items has brought down the average receipts from all sources by $\frac{9}{10}$d. to 3⅞d. per unit.

Revenue Statement.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase
Sale of energy	£6,215	4·05d.	£10,747	3·41d.	−·64d.
Meter rents	196	·13d.	277	·09d.	−·04d.
Supply of lamps, &c., rental of motors	702	·46d.	785	·25d.	−·21d.
Sundry	—	—	12	·00d.	·00d.
Gross revenue ...	£7,113	4·64d.	£11,821	3·75d.	−·89d.

A curious coincidence is shown in the general statement above, where the total revenue for 1898 is exactly the same as the total expenditure for 1899; in each case the sum being £7,113. A works in the position of Blackburn naturally feels the rise in the price of coal as a comparatively large percentage, and when the former figure was down to under ¾d., it is not to be wondered at that there should be an augmentation of over ½d. to slightly more than $\frac{9}{10}$d. per unit for fuel. All the other items in the costs have been materially reduced. Rent, rates, &c., have even fallen in the gross by £10, probably owing to the incidence of taxation. Works costs have been brought below 2d. by the drop of over ½d., while the total cost stands at very nearly 2½d.; this being no less than 46d. better than in 1898.

Cost of Production.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Coal	£1,070	·70d.	£2,892	·92d.	+·22d.
Oil, waste, water and engine room stores.	335	·22d.	506	·16d.	−·06d.
Salaries and wages incurred in generation and distribution.	764	·50d.	1,226	·39d.	−·11d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and renewals of street lamps, carbons, and fittings.	969	·63d.	1,157	·37d.	−·26d.
Works costs ...	£3,133	2·05d.	£5,781	1·84d.	−·21d.
Rent, rates and taxes ..	254	·16d.	244	·08d.	−·08d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	578	·38d.	827	·26d.	−·12d.
General establishment charges, stationery and printing, law charges and insurance	196	·13d.	261	·08d.	−·05d.
Other expenses	—	—	—	—	—
Total costs ...	£4,166	2·72d.	£7,113	2·26d.	−·46d.

The increase in gross profit by £1,761 has enabled the financial charges to be covered and leave a small surplus. Interest and sinking fund absorbed £1,696 more than in the previous year, when there was a net loss of £46. The difference therefore appears as a profit of £19, or about ·006d. per unit, against a loss of ·03d. per unit in 1898. The moderate capital has had the effect of enabling the supply to be given at a very low rate without incurring a net loss.

Profit Statement.

	1898.	1899.
Interest on loans..	£1,659	£2,712
Sinking fund for repayments	1,334	1,977
Net profit carried forward	− 46	+19
Gross profit	£2,947	£4,708

CITY NOTES.

Brush Electrical Engineering Company, Limited.

An extraordinary general meeting of this company was held on Monday at Winchester House, Mr. J. B. Braithwaite, jun., presiding, to consider the agreement with the British Electric Traction Company.

The Chairman said they were holding an extraordinary general meeting because the agreement recommended for adoption between the Brush Electrical Engineering Company and the British Electric Traction Company was one of such importance that they did not feel justified in entering into it without the shareholders' sanction, and as it involved the retirement of some of the directors they felt it was necessary to take them into fullest confidence before entering into it. They regarded the agreement as being decidedly in the interests of the Brush Electrical Engineering Company, and this would be obvious at once, when they considered that they had been engaged for two or three years in making large extensions in their works at Loughborough, in developing every class of traction plant, so that now, he believed, the Brush Company alone among English manufacturers were in a position to supply everything necessary in connection with an electric tramway. They not only built the generators and engines for driving them, but they also built the motors, controllers, car bodies, and also the trucks, so that at the present moment the Falcon Works were able to turn out all the plant in connection with an electric tramway, from beginning to end, of English manufacture. The British Electric Traction Company, on the other hand, was without doubt, the leading British company engaged in the business of electric traction. It was the most powerful organization of the kind in this country, and it seemed at first blush very desirable that the British Electric Traction Company should ally itself with the leading British electrical manufacturing company for their mutual benefit. The agreement would have the effect of securing for the Brush Company the whole of the orders for electrical plant which the British Electric Traction Company might have to give out, thus securing a very large share of the electric traction work which will be going in this country, rendering the capital the Brush Company had expended in putting down their motor and truck shops, and other additions to the works, immediately remunerative, and securing a certain steady stream of

orders for these departments of the works. In itself that was a very desirable thing from the point of view of the Brush Company; on the other hand, the British Electric Traction Company naturally said that if they were going to give this company the whole of their orders they would require a *quid pro quo* which would take the form of a 5 per cent. rebate on all orders which they placed with them for themselves or their affiliated associated companies. The confidence which the B.E.T. Company felt in the Brush Company, and in their own ability to give the Brush Company a large amount of profitable work in the near future, was shown by the clauses in the agreement, which provided that they shall be represented on the board of the Brush Company by three gentlemen, and further than that with the idea of securing some portion of the manufacturing profits for themselves, they were willing to take as many ordinary shares in the Brush Company as shareholders chose to let them have at a fair exchange at the present market prices. They offered to give any shareholder one B.E.T. Co's. share carrying dividend from April 1st, 1900, in exchange for each 7½ Brush shares, carrying dividend from January 1st, 1900. Of course, that offer to take shares was a purely optional one so far as shareholders were concerned. It was not optional so far as the B.E.T. Co. was concerned, for they undertook to take any quantity of ordinary shares. It was entirely optional to Brush shareholders whether they exchanged or retained their shares. In the agreement the B.E.T. Co. gave the strongest possible proof of their faith in the future of the Brush Company, when they practically offered to buy the whole of the ordinary capital, and for the satisfaction of that agreement they ought all to hope that there might be a considerable number of Brush shareholders who would be willing to exchange or sell to the B.E.T. Co. on the terms they mentioned. The larger the interest the B.E.T. Co. had in the ordinary shares, and hence in the manufacturing profits, the more likely they were to continue the agreement beyond the period at which it was possible for them to terminate it. It was obvious that it would never have done for the directors to have handed over the Brush Electrical Engineering Company to any other company, however powerful, and there was a provision inserted in the agreement that it might be terminated at the end of one year by either party; that was to say, that if they considered at the end of the year that the B.E.T. Co had not given them the full volume of orders that they undertook to give, or that the Brush Company for any other reason was dissatisfied with the working of the agreement, they could end it. If, on the other hand, the B.E.T. Co. were dissatisfied they also could end it. It was one of those agreements for an alliance for mutual benefit which for the success of its working, depended entirely upon the goodwill of the two parties entering into it. A number of shareholders appeared to have misunderstood the agreement, thinking that if it was adopted, they would be bound to exchange their shares for those of the B.E.T. Co. This was not the case. If the agreement was adopted, some of the directors would resign, and the B.E.T. Co. would compensate them for doing so in order to make way for three B.E.T. directors to take places on the board. Next, they would receive a large block of orders for electrical plant; and third, every shareholder in the Brush Electrical Engineering Company would for a certain specified period, probably three weeks or a month, have the option of accepting B.E.T. shares as explained. Two things would inevitably happen, and one thing was purely optional. It might happen that no shareholders would exchange, but it might happen that nearly all would do so. The only thing uncertain was the extent of the shareholders' interest in the ordinary shares, which would be acquired by the B.E.T. Co. That was a matter no one could foresee. It would depend upon the individual preference of the shareholders. The agreement was a very simple one; it merely amounted to active alliance between the most completely equipped British electrical manufacturing company, and the most powerful British company which was financing, promoting, and working electric tramways in this country. They all believed that the arrangement would be mutually advantageous, provided it were worked with goodwill, and to ensure that goodwill they proposed to elect to seats on the board three nominees of the B.E.T. Company, in place of some of the present Brush directors, and these resigning directors would be compensated by the B.E.T. Company, to the extent of £2,250 divisible between them. They proposed to elect to seats on the board Lord Vaux, of Harrowden, Mr. C. S. B. Hilton, and Mr. R. P. Sellon (the present manager of the Brush Company). The chairman then formally moved "that the agreement made with the British Electric Traction Company dated January 3rd, 1901, be, and is hereby, approved and adopted."

Mr. J. S. RAWORTH in seconding this motion, said he had been associated with the Brush business for over 14 years; he was their representative on the board of the B.E.T. Company, and he had furthered the completion of this agreement in the full belief that it would be executed in the shareholders' interests. He believed they could not do better for their own selves and the company, than to carry out the agreement as put before them. The B.E.T. Company was already a large shareholder in the Brush Company, and he knew that it was its very strong desire to become a still larger shareholder. Their holding principally consisted of preference shares, but they showed their desire to take some of the risk of the undertaking, and to participate in some of the profits which they believed would grow owing to the very large influx of business that must arise from the agreement if it be carried out.

After a few questions had been asked by shareholders regarding the number of Brush directors that would still remain on the board, the resolution was carried with a few dissentients.

The resignations of three directors were formally accepted, and the three nominees of the British Electric Traction Company were duly elected.

General Electric Company, 1900, Limited.

THE statutory meeting of the above company was held on Wednesday afternoon at the Cannon Street Hotel, Mr. Hugo Hirst presiding.

The CHAIRMAN said that the whole of the share capital, as well as the debenture money, had been subscribed, issued and allotted. The debentures were held by 153 subscribers, and the preference shares by 422 subscribers. The whole of the properties purchased by the new company with the exception of a few leaseholds held on rack rent had been duly transferred to them by the vendors. The debentures of the old company had been paid off, and the mortgage of the new debenture stock had been executed, and the deeds handed over to the trustees. An application has been made to the Stock Exchange for a quotation of the preference shares and debenture stock. It was a most pleasing fact that a very large proportion of preference capital had been applied for and allotted to numerous customers of the firm. So generalwas the confidence of their *clientèle* in them, that they could produce quite a number of instances where not only principals of firms with whom they did business, but also their managers and assistants invested quite a respectable part of their savings in the securities which they offered. A fact no less gratifying was that the staff of the General Electric Company, and their friends, had invested quite a considerable amount in the business, which showed the great confidence they had in the firm. The money thus received, after having paid off old debentures and other obligations of the company, had been deposited in their banks, both in London and Manchester, as practically the whole of it had been pledged to certain undertakings. Electricity still afforded great fields for the enterprising, and with that conviction they had had no hesitation in acquiring 60 acres of additional land adjoining the property mentioned in the prospectus, they had placed the contract for their very large engineering works, a central power-house for a large quantity of most up-to-date machinery, and within a very short period they hoped to have supplemented their present over-crowded works at Manchester and Birmingham with such new additional works which would enable them to undertake at a profit any and every kind of electrical engineering work that has ever been attempted in the country. With regard to the business, he was pleased to state there had been a considerable increase in sales for every month during the nine months that they had been in existence as a new company compared with the respective months of the previous year. It had been particularly bright to see that their young engineering department had succeeded in pulling off some of the largest and most interesting orders that had been offered to manufacturers by the Government, municipalities, and leading electric light companies. One of their oldest departments, in which they considered themselves leading manufacturers in this country—the telephone department—was receiving a most satisfactory impetus through the competition that was now springing up between the Government, telephone companies, and municipal authorities. As regards the incandescent lamp business, he believed the "Robertson" lamp was made in better quality and larger quantities than any other lamp in the country.

Mr. F. WALKER asked if there was any chance of the preference shareholders obtaining ordinary shares.

The CHAIRMAN said that if they ever issued any ordinary shares to the public, the preference shareholders would be considered first. So far they had had a private concern, and the additional capital brought in would be unremunerative till it was in full working order, consequently they could not issue any ordinary shares till they saw the results.

Perth (W.A.) Electric Tramways, Limited.

THE second ordinary general meeting of this company was held at the offices in London last week, Mr. E. Heasman presiding. He stated that the construction and equipment of the lines had been substantially carried out. The best material had been employed, and though that might mean greater capital outlay at the beginning, it would lead to greater economies in maintenance and renewals. Construction was commenced early in 1899, and 10¼ miles of track was now working. The returns were very gratifying. The working expenses were disproportionately high on the first sections of a tramway like this, and the ratio of expenses would correspondingly decrease as further sections were opened. To have earned any profit at all was a very satisfactory feature. In November the gross receipts were £2,412 (or £29,000 per annum) and the working expenses 48¼ per cent. During December the gross receipts were £3,410 (£41,000 per annum), the working expenses being about 51½ per cent. The average receipts for the four weeks ending January 4th were at the rate of £825 per week (£43,000 per annum). Another 2½ miles section is about ready for opening. During the current year, with about 13 miles of track working, they anticipated a profit of £20,000 per year. This would be three times as much as they required to pay the debenture interest. A substantial reserve fund ought to be formed for the redemption of the debentures. More cars would be required. They were confident of obtaining powers for the electric lighting of Perth. After briefly stating their appreciation of the services of the staff, the chairman moved the adoption of the report to June 30th, 1900.

Mr. OLIVER WETHERED seconded, and it was unanimously agreed to. It was resolved to pay £500 to Mr. Rogers, the managing director in Australia, for successful management during the first two years of construction, and £250 to Mr. Somerset, the engineer.

Brompton and Kensington Electricity Supply Company, Limited.—An extraordinary general meeting was held on Thursday last week at Winchester House, Mr. H. R. Beeton in the chair, to consider the confirmation as a special resolution of the resolution which was passed at the meeting on the 20th ult. for increasing the capital of the company by £100,500 by the creation of 20,100 additional shares of £5 each, 8,000 to be preference shares and 12,100 to be ordinary shares, to rank *pari passu* in all respects with the existing 12,000 preference and 27,900 ordinary shares. The resolution was confirmed.

City and South London Railway Company.—The accounts for the half-year ended 31st ult. show a balance, after providing for the debenture stock interest and the full dividends on the 5 per cent. preference stocks (1891 and 1896), sufficient to allow a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum, carrying forward £1,249. The dividend for the corresponding period last year was at the rate of 1½ per cent. per annum, the balance carried forward being £1,267.

Direct United States Cable Company, Limited.—Interim dividend, 3s. per share (3 per cent. per annum), for the quarter ending December 31st, 1900, is payable on and after the 31st inst. £10.000 has been set aside to reserve fund account, and £5,255 has been carried forward. Transfer books will be closed from January 15th to 29th.

Stock Exchange Notices.—Application has been made to the Committee to allow the following securities to be quoted in the Official List:—Commercial Cable Company—Further issue of £177,951 sterling 4 per cent. 500-year debenture stock.

Edmundson's Electricity Corporation, Limited.—The directors have declared a dividend of 5 per cent. per annum on ordinary shares for the half year ending September 30th, 1900.

Globe Telegraph and Trust.—The directors announce an interim dividend of 1s. 9d. per share on the ordinary shares.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending January 11th were £378 19s. 4d.; corresponding week last year, £356 13s. 0d.; increase, £22 6s. 4d. Total to date, £649 9s. 7d.; corresponding period last year, £595 6s. 3d; increase, £54 3s. 4d. Miles open, 8¼.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending January 12th were £122; corresponding week last year £142; decrease, £20. Total to date, £264; corresponding period last year, £283; decrease, £19.

Bristol Tramways and Carriage Company.—The receipts for the week ending January 11th were £3,386 0s. 9d.; corresponding period last year, £2,680 11s. 3d.; increase, £705 9s. 6d.

Central London Railway.—The receipts for the week ending January 12th were £5,676; previous week, £5.847; decrease, £171. Total receipts to date (24 weeks), £128,003. Miles open, 6.

City and South London Railway.—The receipts for the week ending January 13th were £2,041; corresponding week last year, £1,124; increase, £917. Total to date, £4,059; corresponding period last year, £2,268; increase, £1,791. Miles open, 1901, 4½; 1900, 3½.

Dover Corporation Tramways.—The receipts for the week ending January 12th were £153 11s. 1½d.; corresponding week last year, £146 6s. 6d.; increase, £7 4s. 7½d. Total to date, £301 12s. 11½d.; corresponding period last year, £305 5s. 7d.; decrease, £3 12s. 7½d. Miles of track open, 3. Car miles run, 1901, 4,869; 1900, 4,954. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending January 11th were as follows:—D. U. T. Co., electric cars, £3,222 12s. 8d.; ditto, horse cars, £18 9s. 1d.; D. S. D. Co., electric cars, £651 8s. 3d.; total, £3,893 0s. 0d.; corresponding week last year—D. U. T. Co., electric cars, £2,753 13s. 6d.; ditto, horse cars, £111 6s. 1d.; D. S. D. Co., electric cars, £576 18s. 5d.; total, £3,443 18s. 0d.; increase, £449 2s. 0d.; aggregate to date, £6,308 17s. 3d.; aggregate to date last year, £5,506 19s. 6d.; increase, £801 17s. 9d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 37 miles electrically, 7 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending January 13th were £1,512; corresponding week last year, £1,529; decrease, £17. Total to date, £3,055; corresponding period last year, £2,984; increase, £71. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

THE end of a nineteen-day account brings anxiety to the Stock Exchange in the most normal times; the settlement that finished to-day, Wednesday, has proved unusually trying, and in some departments business is semi-paralysed, although the gambling spirit is being briskly fanned in the West African mining division. Investment markets, however, are suffering from an overdose of the Globe, and even now it is uncertain how far the ramifications of its deplorable collapse may extend. The weakness of Consols is another depressing circumstance, and the position of the Bank of England's reserve is not nearly so strong as it should be in such critical times. Consequently, our price lists exhibit few changes, and the only outstanding feature is the flatness of Central London Railway shares. Telegraph securities are a possible thought harder; Electrical Supply descriptions are all quiet, awaiting the advent of the dividends.

There has been some demand this week for the "old-fashioned" supply shares; as the market designates such steady-going investments as Westminsters, St. James's, and Metropolitans. On the other hand, City of London Electric Lighting shares are 10s. lower, the failure of the company to cope with the sudden demand for the current in the recent foggy weather being regarded as a bull point for the competitive Charing Cross and City concern. Smithfield Market Debentures are marked down five points, and the shares should be quoted lower. It is doubtful whether a seller would get more than 1⅜ or 1⅞ if he desired to dispose of his holding.

Curiosity is agog as to how the Brompton and Kensington Company will issue the new capital which it has obtained powers to offer. We understand that no decision has been arrived at on this point. It is singular to notice, by the way, how the company's former title still clings to its shares. It is nearly always House-to-House which are dealt in—very rarely Brompton and Kensington.

Central Londons are badly depressed, the latest cause for alarm being anticipations that the company may shortly be obliged to replace all its present rolling stock with new carriages which shall themselves be equipped with motors, and thus be independent of locomotives. The latter, it is said, are wearing out the line at an alarming rate. It may be just as well to take these reports with an extra large grain of salt. The company's official statement and accounts are due in the course of a week or two, when shareholders, it may be hoped, will "hear something to their advantage."

City and South London stock has not moved upon a disappointing dividend at the rate of 1¼ per cent., and the other electrical railway prices are the same as those of a week ago. City gossip has it that that white elephant, the Baker Street and Waterloo Railway, has been purchased for half a million sterling by the London and South-Western Railway. As this is the company controlling the Waterloo and City, it is, of course, not quite unlikely that the story may have some truth in it. Naturally, the market in Baker Street and Waterloo shares is now as dead as nails, in fact, the only time when any dealings took place was those few days on which the public were invited to subscribe for shares, when the usual pre-allotment carrot was dangled before the nose of the usual animal.

Electric Construction shares are harder in price than is apparent from the official quotation, the new Preference issue notwithstanding. The directors are offering shares of the latter, carrying 7 per cent. dividend, at 55s., which is the price of the existing shares. How quietly the issue was arranged may be judged from the fact that not even the broker to the company knew anything about it until he saw the papers in the Stock Exchange.

British Electric Traction and Brush Electrical Engineering shares are both unaltered, the proposed working agreement being practically ignored by the market. In the manufacturing section Henley's Preference and Callender's Preference are both 5s. better. Last week it was the Ordinary shares of these companies which rose simultaneously; next week we suppose it will be the turn of the Debenture stocks to add a point or two to their prices. Telegraph Manufacturing are also ¼ better, but there has been a slight set back in National Telephones, on fears of a reduced dividend being declared. The Globe Telegraph and Trust announcement, referred to in another column, has had no effect upon the price of the shares.

Telegraph securities are steady, with no fresh developments worth mentioning. The German Government failed to frighten Eastern stocks by their notification that proposals are being considered for the establishment of a new line between Germany and Holland and Shanghai, with Japanese and American extensions. Decidedly a most comprehensive scheme. While talking of telegraphs, it may be just as well to warn our readers not to pay overmuch heed to letters that have been appearing this week in the press, advising a purchase of Anglo-American Deferred stock. The anonymous writer calls attention to the dividend of 27s. per cent. paid last year on the stock, and while he admits that this month's distribution may be less, he does not mention that Stock Exchange estimates are guessing at only 5s. to 7s. per cent. as likely to be the figure. As the official announcement is made on the afternoon of the day on which the REVIEW appears, we cannot say any more on the subject at present.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Jan. 9th.	Closing Quotations Jan. 16 h.	Business done during week ended Jan. 16th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102 xd	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	...	52 — 55	52 — 55	52½	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	...	97 — 99	97 — 99	99	97¾
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	...	10 — 10½	10 — 10½	10 5/16	10 3/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3⅛	3 — 3⅛	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	170 —180	170 —180	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	102 —104	103¼	102⅜
16,000	Cuba Telegraph	10	8 %	7 %	...	6½— 7½	7 — 8	7¼	...
6,000	Do. 10 % Pref.	10	10 %	...	...	15 — 16	15½— 16½	16½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100–104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	...	10 — 10½	10 — 10½	10½	10 7/16
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	136 —141	136 —141 xd	138¾	136½
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98	95 — 98 xd	95½	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	109 —113	109 —113	110	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	...	14 — 14½	14 — 14½xd	14 7/16	...
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) £8 pd.	10	...	...	...	11½— 12	11½— 12	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	112 —117	112 —117	111	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	101	100
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102%	99 —102%	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5¼%	...	10¼— 10⅜	10¼— 10⅜	10¼	...
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	15 — 15½	15⅜	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	31 — 33	31 — 35	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	½— ½	½— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	...	4¼— 4½	4⅛— 4⅜	4¾	4 5/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	12 — 14	12 — 14	...	..
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	6 %	...	4⅞— 5⅛	4⅞— 5⅛	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	94 — 97	94 — 97	95	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	...	99 —102	97 —100	100	98
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4⅜— 5⅛	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4⅜— 5¼	4⅜— 5¼	4⅞	...
23,361	Do. do. Nos. 16,640 to 40,000 £3½ pd.	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	100	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜— 14¼	14¼	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅝— ⅞	⅝— ⅞	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	6 — 7	6 — 7	6½	6¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	103½	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	...	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	...	9⅜— 10⅜	9⅜— 10⅜	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	5 9/16	5¼
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	...	6½— 7	6½— 7	6⅝	6⅜
150,000	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	...	9 — 10	8½— 9½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	13⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4½— 5	4½— 5 xd	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	103 —106	101 —103 xd	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 2	1½— 2	1½	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	..	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	...	12 — 13	12 — 13	12½	12¼
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	111½	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	...	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	...	15 — 16	15 — 16	15¼	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	...	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	80 — 90	80½	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2⅜— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	...	12 — 13	12 — 13	12¾	12⅝

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Jan. 9th.	Closing Quotation Jan. 16th.	Business done week ended Jan. 16th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8½— 9½	8½— 9½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	12½— 13½	12½— 13½	13¼	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	11½— 12½	...	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	½— ¾	½— ¾	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅝— ⅞	⅝— ⅞	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	95 — 97	97 — 99	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	...	10½— 11½	10½— 11½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½— 6½	5½— 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	1¾	1 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2 3/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	13 — 14	13 — 14	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 5¾	5½— 6	5 13/16	5½
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	110	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	8¾— 9¼	8¼— 8¾	9	8⅞
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅞— 5⅛	4¼— 5	5	4 1/16
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	3¼— 3⅝	4	3⅜
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	52 — 56	52 — 56	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	4½— 5½	4½— 5½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½— 4	3½— 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1⅝— 2¼	1⅝— 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅞— 2⅛	1⅞— 2⅛	2⅛	1⅞
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3	2½— 3	3	2⅝
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	101 —104 xd	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	...	13½— 14½	13½— 14½	14½	14⅛
30,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½— 5¾	5½— 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	20½— 21½	21¼	20⅝
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	102	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3¾%	...	8⅜— 8⅞	8⅜— 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13½— 13¾	13½— 13¾	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	...	38 — 42	38 — 42	41	40½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	100 —103	100 —103	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	10 — 11	10 — 11	10½	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 5¾	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	...	94 — 97	94 — 97	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
Consolidated Telephone Construction and Maintenance, 3/—5/-
National Electric Free Wiring, 12/6 paid, ⅛—⅜.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11½—12¾; 1st Preference Cumulative 6 % £5 (fully paid), 6¾—7¼. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 16.

Bank rate of discount 4 per cent. (July 19th. 1900)

MARKET QUOTATIONS, Wednesday, January 16th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	9d.	9d.	..
c ,, Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
c ,, (Electrolytic) Bars ..	per ton	£82	£82	..
c ,, ,, Sheets ..	per ton	£90	£90	..
c ,, ,, Rod ..	per ton	£84	£84	..
c ,, ,, H.C. Wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8½ to 3/9	3/10½	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	48/5	49/10	1/5 dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10 10	£10 15	5/- dec.
g Lead, English Ingot	per ton	£16 7 6 to £16 10	£16 12 6 to £16 15	5/- dec.
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10¾d. to 1/½	10¾d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£124 to £125	£124 to £125	..
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4⅝d.	4⅝d.	⅛d. inc.
j ,, ,, Russian, 10 lbs. ..	per lb.	5⅝d.	5⅝d.	⅛d. inc.
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne and.)	per ton	£23 2 6	£23 2 6	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

THE CASE FOR ELECTRIC POWER DISTRIBUTION.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

(*Concluded from page 54.*)

BY superposing diagrams, figs. 1 and 3, and reducing the useful return to a common basis for both, we get fig. 4, which shows the indicated horse-power required for electrical and mechanical distribution respectively, the line, B C, representing the former and the line, D E, the latter. Distances between B C and D E measured

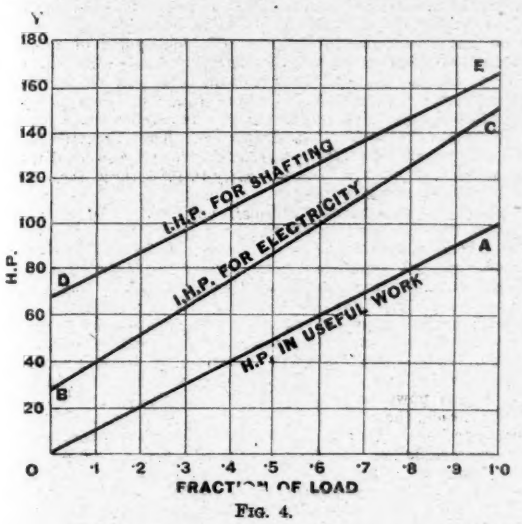


FIG. 4.

on the ordinates show the difference in the indicated horse-power required by the two systems. Observe that at full load we save about 10 per cent. in the indicated horse-power by electrically distributing the power, and at three-quarters, half, and one-quarter loads 16, 24, and 38 per cent. respectively.

The law governing the steam consumption of the engine now demands attention. How is the steam consumption influenced by the load on the engine, and what is the cost of steam per indicated horse-power at various loads? The law connecting the steam consumption with the load has been investigated by several engineers, notably by the late Mr. Willans, who made many interesting and valuable experiments on the subject. Mr. Willans found that in an engine running at a uniform speed and with constant ratio of expansion, the total steam consumption might be expressed with remarkable accuracy in the form $= a + b$ I.H.P., where a and b are constants depending on the construction of the engine. This means that the steam used in the engine is made up of two quantities, one of which is constant and independent of the work being done, the other of which is proportional to the indicated horse-power. For engines which have a variable ratio of expansion the law is somewhat different, but it will be sufficient for our purpose to assume

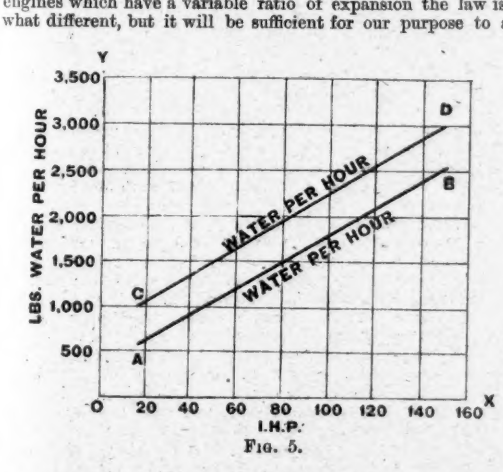


FIG. 5.

that in the engine we have chosen the steam consumption follows the above-stated simple law, and the argument is not altered thereby. Taking 20 lbs. per indicated horse-power per hour as the consumption of steam for a non-condensing compound engine and 17 lbs. for the same engine working condensing, the diagram, fig. 5, shows the results obtained from an engine of 150-I.H.P. Abscissæ give the indicated horse-power, while ordinates represent the total steam consumption per hour. The line, A B, gives the results for condensing, and the line, C D, those for non-condensing. It will be observed that the water taken by the engine when doing no work, but simply running round at full speed and overcoming its own friction, is, in the case of the non-condensing engine, no less than one-third of the steam it requires for running when giving its full power; while in the case of the condensing engine it is rather over 20 per cent. The figures are from actual practice, so you need not worry about their accuracy. In consequence of there being a certain quantity of steam which is independent of the load, the quantity per indicated horse-power increases greatly at light loads in non-condensing engines, and less so in condensing engines; consequently the saving in fuel is not, as has been so often assumed, proportional to the saving in indicated horse-power.

At this stage we may fitly make inquiry as to the capital outlay required for a scheme of electric power distribution. It need scarcely be said that this depends entirely upon the amount of the power and the character of the area over which it is to be distributed. The extent of the works and the number and size of units into which the power is to be divided have all to be considered, so that dealing with general principles my only course is to adopt, for the sake of argument, a fair average and leave it to you engineers to make the necessary correction for each individual case which comes before you. The cost of generators per horse-power varies with their size, and the same holds for motors, the price of the latter running from £5 per horse-power for 50-H.P. sizes to as much as £15 per horse-power for sizes of 3 H.P. For every horse-power delivered at the motor shafts we have to furnish by the generator 1·2 H.P., and as regards the conducting system, the cost of this depends upon the extent of the premises and whether the power is delivered in large or small lots. I am going to assume that, taken all round, the capital expenditure, including generator, switchboard, conductors, motors and fixing, will amount to £20 per horse-power of motors installed, this being, in my opinion, a fair average. For the moment I am not counting as part of the expenditure, on account of electrical distribution, the cost of the engine, as we require an engine in any case, whether we distribute its power mechanically or electrically. If it becomes necessary to consider the cost of the engine it may be taken at £3 10s. per indicated horse-power.

Now, if it is difficult to strike an average for the cost of an electric distribution plant, it is still more difficult to get a reliable average of cost for shafting and belting. The figure I give for this must be considered as subject to great variation. It is taken at £5 per horse-power installed. The depreciation in belting we know to be extremely high, and for the purpose of this argument I shall assume that the all-round depreciation on the plant required for mechanical distribution, including belts or ropes, may be taken at 15 per cent. That on the plant for electrical transmission may be very fairly taken at 5 per cent. Allowing interest at 5 per cent., there requires to be set aside annually to meet interest and depreciation, for electrical distribution £2 per horse-power installed, and for mechanical distribution £1 per horse-power installed. To make the adoption of electric distribution worth while, then, there must be shown a direct or indirect annual gain in its favour of £1 per horse-power, being the difference between these two amounts.

We have now got together such data as are available for our purpose of comparing from the economic point of view the different systems of distributing power. Combining figs. 4 and 5, there is shown in fig. 6 the total steam consumption in the engine both for mechanical and electrical distribution, and it is upon the results here represented that we shall base our estimates of the fuel cost. I shall take it that the motors installed aggregate 100 H.P., and that we use for driving the generator the 150-I.H.P. engine, for which has been given in fig. 5 the steam consumption. Abscissæ represent the horse-power obtained from the motors, and ordinates the steam. The full lines, A B and C D, represent the consumption per hour for mechanical distribution, non-condensing and condensing respectively, while the dotted lines, E F and G H, represent the consumption for electrical distribution. Now, it will be seen that electrical driving has everywhere the advantage over driving by shafting and belting. This saving increases as the power is reduced, so the question arises in getting out our comparison of costs: What proportion of load should we assume to represent the conditions of actual working? Suppose we say that 80 per cent. of the machines run simultaneously, then we save about 10 per cent. of the steam by adopting electric driving, but when running at very light loads—working overtime, for instance—we may, as shown by the diagram, save over 25 per per cent. Possibly, if we assume that the load throughout the year averages three-quarters of the full load, we shall not be very far out. On this basis, by employing electrical instead of belt driving, it will be seen that we save 13 per cent. in steam. Note that though the saving in power at quarter load is 38 per cent., the saving in fuel is, due to the law of the steam engine, only about 24 per cent.

The cash value of this saving depends upon the price of fuel, having regard to its thermal value. This varies in every district. At the pit's mouth it is low; in the London district it is high. You would, of course, be able from the circumstances to assign the proper value in each case, but for the purpose of the present argument we shall assume that every 100 lbs. of steam raised costs 1d., this corresponding to a value for coal at about 18s. per ton. Now, on reference to the diagram, fig. 6, it will be seen that driving electrically at three-quarter load we save 375 lbs. of water every hour we run. According to the price assumed, this is equal in money to 3¾d. per hour, and for 3,000 hours per annum, which allows for some overtime, we get a saving of £46 17s. 6d. due to electric driving.

Note that, provided a similar engine is used for electric and belt driving, the saving is no greater in a condensing than in a non-condensing engine. From the diagram, fig. 5, it will be seen that the addition to the steam consumption is per indicated horse-power

* Paper read before the Civil and Mechanical Engineers' Society.

the same for condensing as for non-condensing, though on account of the quantity of steam, which is independent of the indicated horse-power, being in the former case less, the total consumption for a condensing engine of given size is correspondingly diminished. By electric driving, however, we simply reduce the indicated horse-power, and as the steam to be subtracted for a given reduction of power is the same both for condensing and non-condensing, the fuel saving is not in the least influenced.

It appears, then, that taking this case of mere substitution of electric for belt driving, there is not a large saving in the direction of fuel consumption to be expected. With regard to the belt driving, the assumption was made that friction, including that of the engine, accounted for 40 per cent. of the indicated horse-power, but it must be remembered that though this is a fair average, on occasions friction runs away with as much as 80 per cent., while in some cases only 20 per cent. is lost, and the only way therefore to get at the real waste is to treat specially each particular problem that turns up. It will be readily understood that the balance may, according to circumstances, lie with either method of distribution. It depends largely on the area over which the power is spread.

Again, the saving depends, as we have seen, on the average load. If it is necessary to work a good deal of overtime, when only a few of the machines scattered about the various parts of the works have to run, the saving is increased; on the other hand, if full load is the rule, and partial load or overtime the exception, the saving is not so great. Further, in the case considered, the assumption is made that in adopting electric distribution, *all* the shafting and belting is dispensed with. This, however, is not at all likely, and the question is, even with the best arrangements made for electric distribution, what proportion of shafting and belting is it necessary to retain? Proposals have come before me which admitted of the shafting being reduced to a negligible quantity, but there are cases, on the other hand, where the shafting and belting could not be appreciably reduced by the introduction of motors. One example comes forcibly to my recollection—that of a cotton

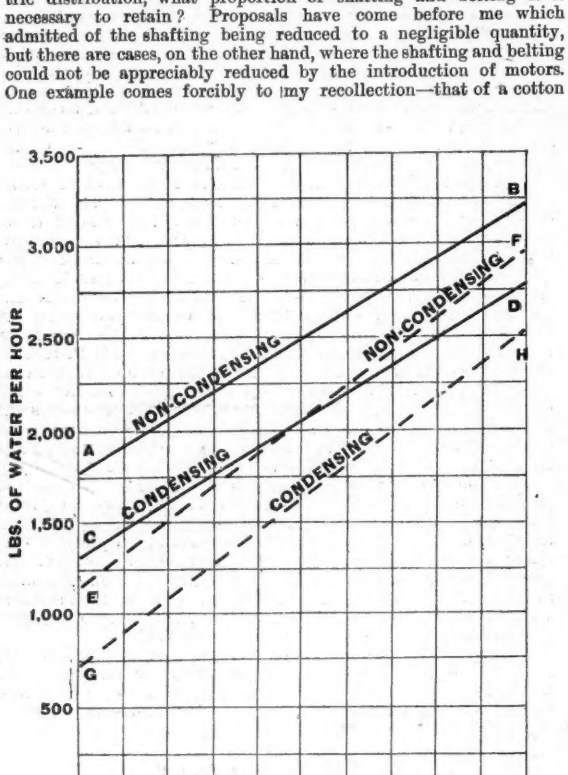


FIG. 6.

mill in India. It was proposed to drive this electrically, but the mill was all on one floor, and the machinery was so compactly and symmetrically arranged, that no point could be found in the distributive system where the introduction of motors would save in friction anything worth speaking of. So far as fuel consumption goes, this is the crux of the matter. Wherever we put in a motor, in the nature of things we lose at once, and between the motor terminals and its shaft, 10 to 15 per cent. of the power we have delivered to that point. If we continue with shafting and belting we save this loss, and the question therefore is: Do we gain, by employing electrical distribution up to that point, such an advantage over distribution by shafting as will justify us in dropping that 10 or 15 per cent.? Undoubtedly we do often, but it was not so in the cotton mill referred to. And from another point of view this kind of case is the worst for electric driving, as a mill generally runs at full load or is stopped altogether. When slack, half or three-quarter time is worked, as the case may be, but they work full load whilst they are at it. Here it may be mentioned that on the Continent, where cheap electrical power is purchased for manufacturing purposes, it is customary for such power to be distributed by shafting and belting. A few motors are installed to drive different sections of the works, just as steam engines might be installed, but it is unusual to employ separate motors for individual machines. In America the same holds good. In textile factories either one large motor or a number of smaller ones are installed, say, from 50 H.P. to 130 H.P., as in a cotton mill lately set to work in Carolina. Again, in engineering works it is usual when the machine tools require less than 4 H.P. each to group them on short lines of shafting, each section taking about 24 H.P.

Lastly, there is, of course, the cost of fuel influencing the saving. If the fuel costs per ton less than I have assumed, always having regard to its thermal value, the saving will be less; if it costs more, the saving will be greater. Once I was asked to advise a company as to the advantage which might be expected from doing away with the large engines driving different sections of their works, centralising the boiler and engine plant, and distributing the power everywhere electrically. As it turned out that the fuel used consisted chiefly of shavings and sawdust, which cost nothing, the conversion would have been, considered from the fuel point of view, the maddest folly, but, as we shall see later, there are other matters to be taken into account besides fuel, and it is just possible that in cases apparently unpromising a consideration of these may sometimes turn the scale. In the meanwhile, remember that upon these three factors the saving in fuel depends. They are: the average load, the amount of shafting and belting which can be displaced, and the cost of fuel, and it is necessary to give these their proper value for each case that arises.

Turning to the replacing of small engines by electric driving, there is here no question as to fuel economy. In works divided into sections of considerable size, each driven by a high-class compound engine, it is no doubt more economical, if the distances are not excessive, to distribute steam through carefully lagged pipes than to adopt electricity and substitute for these engines electric motors; but in the case of small steam engines the results all point the other way. From the diagram, fig. 6, it will be seen that for 75 H.P. delivered we use about 2,500 lbs. of steam per hour for electric driving working non-condensing, and it is safe to predict that if this power were given by five single-cylinder engines of 15 B.H.P. each, the consumption would not be less than 4,500 lbs. of steam per hour. This means 2,000 lbs. excess of steam for every hour worked, or, on the basis we have taken, an expenditure of 1s. 8d., amounting for a year of 3,000 hours to £250. If it were possible to work the generator engine condensing, the saving would be £300 per annum. The electrical equipment certainly costs more than the steam equipment, but taking fuel at the price we have assumed, it would pay in an existing works to put in an electric plant complete and sell the engines as old iron.

But if this saving can be shown by displacing engines which cannot be considered very bad as things go, what shall be said of the saving effected by displacing the rattletrap engines spoken of in the beginning of this paper. The waste of steam is here enormous, and if the power were furnished, not by engines of 15 H.P., but by engines of from 2½ H.P. to 5 H.P., running under usual conditions, the water used would be not less than 8,500 lbs. per hour. This means that electrical distribution would result in a saving of 5s. for every hour run, and for 3,000 hours this amounts to no less than £750 per annum. This is for fuel alone, and does not take into account the reduced wear and tear of boilers due to only one-third of the number being required for steam raising. In such cases, if the cost of coal were only one-third of what we have assumed, it would pay to electrically distribute the power and throw the engines on the scrap heap.

Hitherto we have dealt only with the question of fuel, but there is also the matter of attendance to be considered, and in my opinion electric motors require less attendance than do shafting and belting, even if the latter are looked after properly. But the fact is that while motors are generally under the supervision of an intelligent person, shafting and belting are too often left to the mercies of people who have been in no way trained to think; and consequent on the services of an electrician being sometimes enlisted, it has been thought that the cost of attendance on electric plant must be considerably more than on shafting and belting plant. This is by no means the case, for as there is no machine to compare in mechanical simplicity with an electric motor, it requires very little attention, and the greater part of the belt mending being dispensed with, there is, I think, in the matter of attendance, a clear gain for electric distribution.

Where electric motors are substituted for small engines, however, there is no question as to the saving in the matter of attendance. The wearing parts of an engine are many, whereas in motors these are reduced to two bearings, and by making them substantial, and providing them with automatic lubrication, their wear may be rendered excessively small. Electric conductors properly insulated will last for many years without the least attention, but this can scarcely be said of a range of steam pipes erected in the open, and subject to contraction and expansion. There are joints to make and keep right, there are also glands to pack in the engines, and working joints to be constantly taken up if such poor efficiency as is possible to the system is to be maintained. But—and this is the melancholy truth—the attention is not given, and for the simple reason that the engines will work without it. Let steam blow from the pipe joints; let the engine piston leak; let water stream through all the glands, and still the engine will work. That is the mischief of it. If an engine refused to work with either of these defects it would have to be kept in order, and minimum waste would be thus ensured. But it continues to run with all its faults, and an enormous coal bill bears witness to its inefficiency, and to the fact that because it will run anyhow it does not get the attention that it ought to.

Now, it is different with electric motors. These require considerably less attention than engines *should* get, and very much less attention than they *do* get, but they insist that the little attention

which is required shall be given to them. They must be kept clean and dry; and when we have said this we have said all, as good motors will, working under these conditions, run for an indefinite period without giving trouble. If these conditions are not fulfilled, a breakdown is likely to result, with consequent stoppage, for a motor will not run having a defect which renders it inefficient. They run, therefore, at their proper efficiency or not at all; they do not with the lapse of time eat electricity as engines eat steam; they need but little looking after, and the nature of the attention required is such that everything under this heading can be carried out systematically and at small cost. By keeping an eye on the current indicators we can always tell what is going on in an electric system, but working with small steam engines there is nothing to indicate when the steam consumption becomes abnormal. Again, the boilers are generally dotted about the works, a couple here, a couple elsewhere, and so on. By centralising the boiler plant, we can with electric distribution effect further economies in the attendance and further reduce losses, whilst, needless to add, there is in electric conductors no waste analogous to that due to condensation in steam-pipes which goes on whether the engines are running or not.

Hitherto we have dealt with direct savings in fuel and attendance, and these appeal principally when proposals are before us for electric installations in existing works. When laying out new works the object, of course, is to adjust exactly the means to the end—that is, to arrange everything so that the particular articles manufactured shall be produced in the best quality at the lowest cost and with the geatest expedition. Now, when shafting was the only means at our disposal for distributing the power, the machines had to be located with regard to the most convenient arrangement of driving, and in many instances the position which best suited the shafting did not agree with the position of greatest suitability for the work to be done. With electrical driving it is altogether different. Shafting cannot be made to turn corners without cumbrous and noisy gear, but electric conductors can be led anywhere without trouble. While with belt driving, machines must be installed with special regard to the run of the shafting, electric driving places no restriction as to the position of the machines, and they can be placed with regard only to economy in production. It is conceivable that the advantages secured by electricity under this heading may in many instances be so great as to dwarf the direct savings of which I have already spoken, and this is what was in my mind when I remarked a few minutes ago that fuel was not the only thing to be considered. Quite apart from any saving of labour in the attendance on the distribution plant, we have the economy of labour in production which results from our being able to place our machines in the positions best suited to secure continuity in the treatment of the raw material, and this is a very great advantage. Again, as regards cost of plant, having no time-worn machinery to displace, we have not to make for new works any sacrifices of capital. The result of all this is an increased output proportionally to the capital outlay in machinery, while better lighting of the shops, due to the absence of overhead shafting and the greater cleanliness resulting, undoubtedly make for the same end. He would, indeed, be behind the times who would think of laying out new works without taking seriously into consideration the advisability of distributing the power by electricity instead of by the ancient method of shafting and belting. It is not contended that increased output will necessarily follow a displacement of small steam engines by electric motors, as here the economies are chiefly in the direction of diminished coal bills and less labour in attendance. In displacing shafting and belting, however, where the saving in the coal bill and attendance is not so marked, we have to look to the increased output as constituting the chief advantage.

Wherever electric motors have displaced small steam engines large savings have resulted, and cases have been known where the whole cost of the electrical plant has been returned in one year as saving in fuel and wages. In dyeing, bleaching, calico printing and paper works, in sugar refineries, in sawmills, in iron and steel works, in ship-building and bridge-building yards and boiler shops, the electric motor has pushed the steam engine out, to the great advantage of the producer. As applied to haulage and pumping in mines and collieries, electricity has proved invaluable. For driving live rolls, bending rolls, punching machines, shears, portable drills, and the other tools about an ironworks, the electric motor is by far the most efficient appliance; while for working cranes, hoists, elevators, turntables, fans, pumps, and performing the like functions, it has no equal. When once an installation is put in, it takes very little time to appreciate the possibilities of electricity. Beginning possibly with a small electric light installation, in the course of time two or three motors are requisitioned to drive out-of-the-way machines; by-and-bye more motors are added, and so the development goes on until it is determined to adopt electricity wholesale for driving the machinery. This is history which has repeated itself over and over again.

Electricity, moreover, stimulates expansion on account of the extreme flexibility of the electrical system. When a new machine can be planted down anywhere without reference to existing drives it is a very different matter to having to consider how the shafting can be extended, how it can be carried from building to building, whether walls are strong enough to support it, or how steam is to be led to the spot. In this matter of convenience there is really no comparison possible between the electrical and other methods of power distribution, the facility with which electric conductors can be extended and led in any desired direction, and the extreme simplicity of the electric motor, placing it far and away beyond rivalry.

Again, not only does electricity save money because it provides us with a better method of distributing power, but consequent upon its having been recognised by the mechanical engineer as a trustworthy agent always available for his use, he has been led to devise entirely new ways of doing things, by which the cost of production has been greatly lessened. I need only cite the economies which, due to the use of electricity, can be derived from the utilisation of blast-furnace gases. The gas is burnt in gas engines or under boilers for steam engines, the engines driving electric generators, from which power is distributed electrically to motors placed all over the works. Such a plant has been running at the rail mills of the North-Eastern Steel Company, of Middlesbrough, for some time now. Steam is generated in gas-fired boilers to supply horizontal compound-condensing engines having two-phase generators directly mounted on their crankshafts. Part of the current is used at the ironworks to drive the motors for working the ram and charger for the coke ovens, with the disintegrator, elevators, and other accessories of the coking plant, and part is transmitted through overhead conductors to the steelworks, there to be distributed among motors driving the mechanics' shops, the travelling cranes, saws, rail straighteners, and pumps, and put to all the various uses which can be found for motors in an up-to-date rail mill.

The mechanical engineer should be as keenly alive to the advantages gained by electric distribution as he is to the advantages gained under different circumstances by hydraulic distribution or compressed air. This does not mean that he should be able to design either electric, hydraulic, or pneumatic machinery, which is properly left in the hands of competent experts, but he should be thoroughly conversant with the possibilities of all the appliances from which he has to choose. We should say that the engineer who did not know how a steam or gas engine or water-motor acted was ignorant of his business—in fact, we should not call him an engineer at all—and no engineer can claim to be of the twentieth century who does not possess some notion of magnetic fields and the generation of electric currents. I want to emphasise this because I think that the application of electricity would have gone ahead more if engineers had taken more trouble to understand it, and it is certainly their business, as I have said, to be familiar with the nature of the tools they have to work with. There is nothing particularly subtle about the construction of an electric generator, and engineers should be as familiar with electric conductors as they are with steam or water pipes; though they are wrapped in rubber there is no reason why they should be wrapped in mystery.

In concluding this paper, mostly written in the train, I would remind you that I have by no means exhausted the subject. On the contrary, I have been obliged to confine myself to a general treatment, leaving members themselves to fill in the details applicable to each particular case. For the purposes of the argument it has been necessary to make an assumption here, and a supposition there, and to adopt hypothetical values elsewhere; but an honest endeavour has been made throughout to present the case fairly. It is nothing to us what vehicle be employed for the achievement of our ends. We have to select the best, but beyond doubt there is an extremely strong case for adopting electricity for the distribution of power in the great majority of industrial operations, and often when, as in many instances, it involves the scrapping of existing plant. I have in this paper assumed that the aggregate horse-power of the motors installed is equal to the power which the generator can supply. As we have taken the average running load of the motors to be three-quarters of the power installed, obviously the generator would do smaller; but having regard to the temporary loads due to electric cranes, turntables, hoists, &c., we may as well let the relative proportions stand, as the aggregate capacity of the motors to the capacity of the generator depends entirely upon the nature of the business carried on. In no case need the generator be larger than we have assumed, and if it is too large, the difference is against electric distribution, both as regards capital outlay and running charges. We are, therefore, on the safe side.

And so I bring this somewhat sketchy contribution to a close. If, in calling your attention to the great field which is opening up to the engineer in the electrical distribution of power, I have been fortunate enough to interest you, I am very well satisfied.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE USE OF ALUMINIUM AS AN ELECTRICAL CONDUCTOR, WITH NEW OBSERVATIONS UPON THE DURABILITY OF ALUMINIUM AND OTHER METALS UNDER ATMOSPHERIC EXPOSURE.

By JOHN B. C. KERSHAW, F.I.C.

(*Abstract of Paper read January 10th*, 1901.)

I.—INTRODUCTION.

THE high price to which copper has been forced in recent years by a combination of natural and artificial causes—a combination which it is unnecessary to discuss in this paper—has led to renewed interest in aluminium as a substitute for copper in electrical power transmission schemes.

II.—RELATIVE COSTS OF COPPER AND ALUMINIUM.

In order to compare the price of aluminium with that of copper when used for conducting purposes, it is necessary to make allowance for the fact that the specific gravity of aluminium is rather less less than one-third that of copper, and that its conductivity for wires of equal sectional area is only from 50-63 per cent. that of the more common metal. The following formula is useful for calculating

the relative prices of equal lengths of bare conductors of the two metals of equal electrical capacity.

$$\frac{s \times P \times c.}{s \times p \times C}$$

In this s, P, and C represent the specific gravity, price, and conductivity of copper, while s, p, and c represent the corresponding values for aluminium.

Taking the most reliable values for the physical constants of the two metals, and the most recent market prices, namely—

s	8·93	s	2·68
C	100	c	59
P	£91 per ton.	p	£224 per ton.

and inserting these in the formula given above, we obtain the following price ratio:—

$$\frac{8{\cdot}93 \times 91 \times 59}{2{\cdot}68 \times 224 \times 100} = \frac{798}{1{,}000} = \frac{\text{Cu.}}{\text{Al.}}$$

Expressing this ratio in another manner, £798 expended upon copper will equal £1,000 expended upon aluminium for the same length of wire of equal carrying capacity; and aluminium is, therefore, much the dearer metal of the two.

Special rates are, however, offered where large quantities of aluminium are taken in rod or wire form for electrical purposes, and in the United States large quantities of the new metal have been sold at 29 cents per lb. = £135 per ton.*

Using this figure in the formula given above, the cost ratio for conductors of equal length and equal carrying capacity becomes—

$$\frac{8{\cdot}93 \times 91 \times 59}{2{\cdot}68 \times 135 \times 100} = \frac{1{,}325}{1{,}000} = \frac{\text{Cu.}}{\text{Al.}}$$

and copper is seen to be the more costly material.

III.—Installations of Aluminium in the United States and in the United Kingdom.

The low price at which aluminium is being sold for conducting purposes in America therefore explains the readiness of electrical engineers in that country to adopt the new metal. It may be explained here that at present there is no talk of using aluminium for insulating conductors; the greater sectional area of the metal for equal carrying capacity (1·68 : 1·00) rendering it impossible to use it for such covered conductors, until it has fallen to a much lower price relative to copper.

The following are the particulars of some of the bare aluminium transmission lines already completed across the Atlantic.

At Niagara Falls there are two aluminium transmission lines. Both these lines are short, and are stated to be working satisfactorily.

The Hartford Electric Light and Power Company have an aluminium line between their generating station at Tariffville and Hartford—a distance of 11 miles. The diameter of the stranded cable used is ¾ inch, and it weighs about 1,500 lbs. per mile.

The aluminium transmission line of the Snoqualmie Falls Power Company has been frequently described in the technical press. It runs between the Falls and the two towns of Tacoma and Seattle. Its total length is 34 miles. The aluminium used has been alloyed with 1½ per cent. of copper, and the increased tensile strength of this alloy has enabled spans of 120—150 feet to be safely used.

The Blue Lakes Power Company have an aluminium line in use between their power house at Blue Lakes and Stockton—a distance of 36 miles. The line originally erected has been replaced by one of greater carrying capacity, and 1,000,000 lbs. (446 tons) of the metal have been used for the new line. At 29 cents per lb. this represents an outlay of £60,400 (or £1,677 per mile) for the metal alone.

One of the most interesting of the power transmission schemes in U.S.A. for which aluminium is used, is that of the Telluride Power Company. This company generates current at Provo, in Utah, and distributes it over an 80-mile circuit to the mines at Mercur and at Tintic.

Other power companies in America, in connection with which aluminium is used, or is about to be used, in place of copper, are the following:—

1. North Yuba Power Company, 63 miles.
2. The Municipal Supply Company, 18 miles.
3. The Big Cotton-Wood Power Company.
4. The Standard Electric Company. The company has been floated to develop a scheme for supplying San Francisco from a generating station in the Sierra Nevada Mountains, 150 miles distant. The success of this project depends upon the possibility of using and maintaining the proposed pressure of 60,000 volts. It has been decided to use aluminium cables for the scheme; and estimates have been prepared.

In addition to the power-transmission lines named above, aluminium is being used in place of copper for conducting purposes by the Waxahachie Electric Light Company, of Texas; by the North-Western Elevated Railroad Company, of Chicago; by the Kansas City and Leavenworth Electric Railroad Company; and by the Manhattan Elevated Railroad Company, of New York. For telephonic and similar purposes it is in use by the Pennsylvania Railroad Company, by the Pacific States Telegraph and Telephone Company, and by the New York Telephone Exchange. In this country the Northallerton Electric Lighting Company have four miles, and the British Aluminium Company, at their Foyers Works, have several miles of aluminium in use for various purposes; and the Post Office authorities are making experimental trials of the metal for long-distance telephonic communication.

The difficulty of soldering aluminium has been surmounted in most of these schemes by using mechanical joints, the MacIntyre sleeve-joint being that usually adopted. In one or two cases, as at Niagara and at Northallerton, soldered joints have been made, but the writer doubts whether these will prove as satisfactory.

This summary of the chief installations of aluminium as an electrical conductor in the United States and in this country, shows that considerable progress has been made. In time the metal, *if it be found to possess the requisite durability*, may become an important rival of copper in this new field of usefulness.

IV.—Durability of Aluminium and other Metals under Atmospheric Exposure.

In order to obtain independent and reliable figures concerning the effects of exposure upon aluminium, the writer, since October, 1899, has been carrying out two series of observations in the North of England. The samples of aluminium used are in rod and wire form, and were kindly placed in the writer's hands by Messrs. T. Bolton & Sons, of Oakamoor Wire Works, and by the British Aluminium Company. In order to make the investigation more complete, the inquiry was extended to all metals and alloys used for electrical conductors, and samples of copper, tinned copper, and of galvanised iron wire were also sent to the writer by Messrs. T. Bolton & Sons. It is a curious fact that there would appear to have been no previous scientific observations upon the durability of these metals or alloys under atmospheric exposure, and the choice of the metal or alloy for overhead wires in any particular district has apparently been settled by custom rather than by scientific knowledge.

The methods of observation adopted by the writer in his experiments were as follows:—

The rods and wires were cut into 2-feet lengths, and were mounted upon glass insulators in two frames, so that their position was parallel one to the other, and horizontal with regard to the ground.

The frames carrying the wires were so placed that the drops of water collecting upon the wires in wet weather could not by any chance pass from one wire to another, and thus bring electrolytic action into play. Each length of wire was carefully marked and weighed before commencing the exposure, and the weights recorded. The one frame with its nine insulated sample wires was exposed upon the roof of a building in St. Helens, Lancashire, from October 11th, 1899, to August 23rd, 1900, and the second frame was similarly exposed at Waterloo, Lancashire, for the same period of 10 months.

The climate of St. Helens is probably too well known to need description, but it has improved considerably in recent years, owing to the closing of several chemical works. The place in which the wires were exposed is now singularly free from chlorine and hydrochloric acid gases.

Waterloo is on the Mersey, six miles north of Liverpool, and its atmosphere is that of an ordinary west-country seaside town, *plus* much sand. During the exposure period of 10 months the frames were not touched or moved. At the end of this period the wires were removed from the frames, cleaned from the soot and dirt of all kinds which had accumulated upon them, and after thoroughly air drying, were re-weighed. The results are set forth in the Table:—

Table I.—Results of Exposure Tests of Aluminium and other Wires.

Composition and form of sample.	Waterloo set; 10 months.		St. Helens set; 10 months.	
	+ = gain − = loss in weight.	Remarks.	+ = gain − = loss in weight.	Remarks.
	Per cent.		Per cent.	
Aluminium rod No. 1	nil	These 5 samples were all pitted, especially on the under sides, where water-drops had collected and dried.	+ ·27	These 5 samples were very badly pitted. Dirt had settled in their corrosions, and could not be removed by scrubbing.
„ „ No. 2	+ ·18		+ ·51	
Aluminium wire No. 1	+ ·41		+ ·88	
„ „ No. 2	nil		+ ·83	
„ „ No. 5	+ ·55		+ ·54	
Galvanised iron wire No. 1..	− ·15	No change in appearance to the eye.	− 1·44	Badly corroded. Zinc partly eaten away.
Galvanised iron wire No. 2..	− ·16		− 2·13	
Copper wire No. 1 ..	nil	Oxidised on surface, but not pitted or corroded.	− 1·65	These wires were perfectly black, and could not be distinguished.
Tinned copper wire No. 1..	nil		− 1·31	

The above figures show that the aluminium wires and rods had nearly all gained in weight during the 10 months' exposure, the gain varying from *nil* up to ·83 per cent. on the weight of the original wire. This gain must be attributed to the corrosion of the rods and wires, and to the settling of soot and dirt in the crevices. No amount of scrubbing would remove this dirt. The weights of these aluminium rods and wires were therefore of very little use in determining how far they had suffered by the exposure, and the two samples of aluminium wire marked No. 1 in Table II., were submitted to conductivity and tensile strength tests.* The results are given in the following Table.

* Messrs. T. Bolton & Sons inform the writer that in this country £170 per ton is quoted for large orders of the wire.

* These tests were made by the Faraday House Testing Institution.

TABLE II.—TESTS OF ALUMINIUM WIRE FOR CONDUCTIVITY AND TENSILE STRENGTH.

—	Conductivity; copper 100.	Tensile strength; tons per square inch.
Original wire * ...	51·3	13—16*
Waterloo sample ...	51·4	12·06
St. Helens sample ...	46·6	11·15

* This test was supplied by the firm from whom the wire was obtained; and it is not, therefore, strictly comparable with the others.

It has been customary to assume that the aluminium wire supplied for electrical purposes has a conductivity of from 57—63 per cent. that of copper, taking equal sectional areas of the two metals. The following figures were, in fact, sent to the writer with the samples of aluminium wire used in some of these experiments:—

Sample wire.	Composition.	Conductivity; copper 100.	Tensile strength; tons per square inch.
1. Rod	98·99½ % Al.	60—62	16—18 tons.
2. Wire	99 % Al.	65	13—16 tons.
3. Wire	99 % Al., 1 %, Fe	62	16—18 tons.

Samples 2 and 3 were, however, submitted to independent tests for conductivity before exposing, and it was found that in place of conductivities of 65 and 62 per cent., they only possessed conductivities of 51 and 54 per cent. respectively. It is, of course, known that pure aluminium has a conductivity 63 per cent. that of copper; and the low conductivity of these samples can only be explained by the presence of iron or other metals introduced to increase their strength. The conductivity tests supplied by the firm in question were evidently based on surmise, not on actual results.

The tests given in the last table show that although the St. Helens wire had gained in weight, yet considerable loss in conductivity and tensile strength had resulted from the exposure and consequent pittings. The Waterloo samples, although pitted to a less extent, had not lost in conductivity, and the tensile strength had probably not suffered although in the absence of a special test of the original wire it is impossible to be quite certain on this point. The remains of these two sample wires are here on the table for examination by those interested in the subject, and photographs of the more badly corroded wire are also exhibited.

Examining the first table again, in order to study the results obtained with the remaining wires, we see that both in Waterloo and in St. Helens the galvanised iron wires had lost in weight, the losses in the latter case being serious and amounting to 1·44 per cent. and 2·13 per cent. of the original weight of the wires. In this case almost the whole of the zinc had been dissolved away by the action of the acid gases, and the exposed iron was badly oxidised. The two Waterloo samples were, on the other hand, bright and clean, and to the eye did not appear to have suffered.

The copper and tinned copper wires exposed at Waterloo were oxidised on the surface, but no pitting had occurred, and there was neither loss nor gain in weight. The two samples of similar wire exposed at St. Helens had both lost in weight (1·65 and 1·31 per cent. respectively), and as the whole of the tin had been dissolved off the tinned copper wire, it was impossible to distinguish one from the other.

V.—CONCLUSIONS.

It is perhaps unwise to found any general conclusions upon the results of these observations, since they refer to two districts only. The British Isles can afford a very wide and ample selection in the way of climates. It would, of course, be interesting to have similar series of observations established in London, and in one or more of our large cities with a manufacturing population—say, Manchester, Glasgow, or Sheffield; but at the moment the writer is unable to establish these. The investigation, however, proves that the aluminium wires at present sold for conducting purposes in this country are not perfectly resistent to atmospheric corrosion, and that in the atmosphere of a town where sulphurous acid gas exists as an impurity in the air the metal is very badly attacked.

Though St. Helens is certainly an exceptional town, it is probable that in any large town burning a large amount of coal, either for domestic or for manufacturing purposes, the atmospheric conditions will approach those obtaining there, and that the various metals will be attacked to a somewhat similar degree.

Under such conditions all metals used for overhead conductors are subject to attack, and aluminium is unsuitable for use, owing to the pitting which occurs. In such towns it is advisable to use copper for all overhead wires, and the proposal to use aluminium, *especially for overhead trolley lines*, must be condemned.

In country districts or in small towns, where the impurities present in the air are reduced to a minimum, all metals experimented with seem to be fairly durable, but the slight pitting of aluminium which occurs—even in such an atmosphere, may prove serious; for by allowing the lodgment of small particles of foreign matter it may in time lead to the disintegration of the whole mass of metal.

Upon this point the researches of Ditte are of importance.

The observations are being continued at the two localities named, and on a future occasion the author hopes he may have the pleasure of presenting further figures on this subject for your consideration.

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

PRACTICAL NOTES ON WATER-POWER FOR ELECTRICAL PURPOSES.

By R. F. YORKE, Member.

(*Paper read January 9th*, 1901.)

THE utilisation of water-power is one of the most interesting subjects with which an engineer can have to deal, and to electrical engineers especially it appeals very strongly.

There exists a great similarity between the laws governing the use of water and those governing the use of electricity. Lord Kelvin, in describing and explaining electric phenomena, when referring to this similarity, has termed it the "Hydraulic Analogue," and the analogy crops up frequently in various ways.

Water-power is also interesting from the fact that no two schemes for its development are exactly the same. Every scheme, therefore, must be carefully considered on its own merits, as the local conditions themselves vary so greatly. At one time it may be the utilisation of a large river with only a few feet fall, and another time a small burn with a fall of several hundreds of feet. With such a great difference in water-power problems it is obvious that the methods of developing them must also differ. It need hardly be said that in order to obtain the best results, it is of the utmost importance to provide the right plant to suit each particular locality.

It is impossible in the space allotted to this paper to go into the whole question of utilisation of water-power, embracing as that would do the construction of dams, reservoirs, and the construction of all the various types of turbines, &c. So it is proposed, therefore, only to discuss some of the principal types of plant used in this country, and to indicate the particular conditions for which they are most suited; and also to deal with some practical details which experience has shown to be useful, and concerning which information is not readily obtained from ordinary sources.

Water Wheels.—Before the advent of the turbine the water wheel was the recognised method of obtaining power, and there are still a great number of these scattered over the country driving mills, saw-benches, &c. For electric lighting and power, however, unless the local conditions are extremely favourable, water wheels labour under many disadvantages, where continuous running at all times and seasons is a necessity. In the first place their use is limited to moderate falls, and in flood time, unless a considerable drop is allowed in the tail race, the wheel becomes drowned. In heavy frosts also the wheel is liable to become stopped through ice. The speed of a water wheel is also very slow, and considerable gearing is required before the dynamo can be driven at the required number of revolutions. Still, where it is desired to utilise existing water wheels, they may, by taking the necessary precautions, do good work. The author has found that many water wheels in this country are run at too high a speed, and by changing the gearing increased power and efficiency have resulted.

The author has, however, at present two installations worked by means of water wheels. In one case the electric light is only required during the summer and autumn; and in the other case there is a lake 15 miles long at the back of the river, so that there is always a large and certain supply of water at all times of the year.

Turbines.—There is no single or universal type of turbine which is applicable to all and every form of water power. Each one has to be designed for its own particular purpose. They may be distinguished under two principal classes: *first*, "Impulse" wheels, and *secondly*, "Pressure" or reaction wheels.

For high falls, say, over 200 feet, wheels of the "Impulse" type are the most advantageous. The best known in this country are the Girard and Pelton wheel type.

The Girard is especially applicable where the power has to be varied, as the efficiency is high for small loads, and also when the supply of water is variable it can be utilised to the best effect. The Pelton wheel is the simplest and cheapest form of turbine there is, and where the supply of water is regular and the load constant, such as when charging accumulators, this type gives excellent results. I have sometimes employed two wheels on one shaft, each wheel being fitted with a separate nozzle.

With these forms of impulse wheels, the effect of suction below the turbine cannot be utilised, as the wheels must run perfectly free. However, as they are only used on high falls, the few feet lost in this way are of no great consequence.

For medium falls, below 200 feet and above 50 feet, the author's experience has chiefly been with reaction wheels of the "Vortex" type invented by Prof. James Thomson. One of the very first that was made is in use at the present time, working under 80 feet head. Its age must be at least 42 years, so that it has done well. With this type on a good fall it can generally be managed that the speed of turbine and dynamo can be arranged to coincide, so as to admit of direct coupling. One advantage of the Vortex turbine is that the wheel is balanced. The water entering the circumference of the wheel divides into two and escapes at either side of the centre. This necessitates two suction pipes, but where the length of suction pipe is long the two pipes may be led into one by means of a Y piece.

If the fall is under 50 feet, turbines of the "reaction" type, such as the "Vortex" or such as the "Waverley" type, may be employed. In the former the speed will be slower, and belting or gearing will have to be used. With the latter (the Waverley) the speed is much higher owing to the small diameter of the wheel, which is constructed on the principle known as that of "mixed flow." It is

therefore possible, by using this form of turbine, to couple the dynamo and turbine together even in the case of comparatively low falls. On the other hand, this type of turbine can only be used with advantage when the head remains constant. Should this vary from floods or any other cause, the speed of the turbine is at once reduced.

When it is important to maintain the speed constant under varying conditions of supply and head, the "Jonval" type of turbine is the one recommended. In this case the flow of water through the turbine is parallel with the axis, and considerable variation in the speed can be permitted without greatly affecting the efficiency. This form of turbine has already been adequately described by Mr. A. Steiger in a paper read before the Institution some four years ago, and I will therefore only say that the Swiss engineers have achieved some remarkable results in maintaining the constancy of the speed under greatly varying conditions.

At Chèvres, for instance, by fixing two turbines on the same shaft and constructing the wheels in the form of a cone, they have been able to maintain a constant speed of 80 revolutions, with as large a variation of head as 50 per cent., viz.:—30 feet in winter and 15 feet in summer.

As a contrast to this the author recently had occasion to inspect an installation where turbines were working under a similar low fall. In slight floods, when the head was reduced only 10 per cent., the power available fell off very rapidly; and when it was reduced by 20 per cent. no power could be obtained at all.

Such cases show it may happen that where water power has been condemned for being unreliable, it is the engineering that is at fault and not the water power.

Suction.—In every form of reaction wheel the suction principle can be employed. This is a most valuable property, as the turbine can be fixed well above flood level, although it is not advisable to exceed 25 feet. The suction pipe or pipes are carried down into the suction well, sufficient depth of water being allowed below the bottom of the pipes, and the outlet to the tail race should be constructed so that the bottom of the pipe or pipes may always be submerged. As a rule suction pipes are carried vertically downwards; but in some cases it is not possible to do this without going to great expense.

With regard to suction pipes the author has had some unique experiences which are worthy of notice. In many cases it would be extremely convenient to lay these pipes on the slope; but it is found in practice not to answer, as the vacuum under this condition cannot be maintained. The cause of this the author attributes to the dissolved air in the water being set free under the diminished pressure, and the bubbles of air rising to the top of the pipe on the slope, the air will gradually run up to the upper side of the pipe and accumulating there destroy the vacuum. The effect will be readily seen by opening, say, a bottle of soda water and holding it at the angle of 45°.

To meet this difficulty in practice, where a vertical pipe cannot be used directly under the turbine, the suction pipe or pipes must be taken out horizontally, *then* vertically downwards. It will be readily understood that the air bubbles in the horizontal part of the pipe cannot accumulate, as, when the turbine is working, the flow of water sweeps them onwards.

The author has used this arrangement of suction pipes in several cases with success, and it has now been adopted by leading turbine manufacturers in this country.

Lades.—It is only in exceptional circumstances that the actual vertical fall of a river or stream can be obtained. As a rule it is a series of falls distributed over a considerable distance that have to be utilised. This necessitates the construction of a head, race, or lade, carried along on the contour till the desired difference of level between it and the river is obtained.

In designing the lade the principal factors to be determined are the size and the gradient, so that the volume of water required may possess the requisite velocity. In practice the velocity should be, as a rule, from 2½ to 3 feet per second, which is sufficiently low to prevent scouring, and yet sufficiently high to prevent the water freezing too quickly in winter. (See Appendix.)

Pipes.—An important detail with regard to water-power work is the size of the pressure pipes to be used. This is the usual stumbling block with those who have not had much experience in water-power work, the tendency being to put down pipes of insufficient size. The quantity of water yielding power for a given fall is easily calculated, but the size of pipe is often taken from tables giving simply the free discharge of water. This table is useless where the water is required for power purposes, because not only is it necessary for a certain quantity of water to pass through the turbine, but there has to be a certain amount of pressure at the back of it. This pressure can only be maintained by allowing the water in the pipe to flow through comparatively slowly.

With a turbine of a given size, if the pipe be too small the velocity of the water will become too great, and the result will be to set up friction producing a back pressure, which is equivalent to a reduction of the working head. There must be, of course, some amount of friction even with a moderate velocity, but in practice, for small pipes, say up to 10 inches, the velocity should not exceed 2½ cubic feet per second. For large pipes, say, 20 inches, the velocity may be, say, 5 feet to 6 feet per second, without involving too great a loss of pressure. The length of pipe must, of course, also be taken into consideration, and from tables the loss of head due to friction in the pipes can be calculated. The actual horse-power, of course, delivered by the turbine depends on the working head after the loss has been allowed for.

Water-power —Intakes.—In utilising mountain streams it is necessary to make special provision at the intake. Perhaps at the first visit it may look extremely simply to build a small dam and take a pipe from it; but after heavy rain, or a spate produced by melting snow, these usually clear mountain streams become wild torrents, carrying down sand, stone and other *débris*. If this sand is allowed to pass through the strainer into the pipe it will play havoc with the turbine wheel, cutting it to pieces in a very short time.

To meet this difficulty a method which the author has adopted, and which works well, is what may be termed the "level tank" system. A tank is constructed of stone or cement in the usual way, of sufficient size to receive the strainers, and it is built on a level with the dam across the burn. A large pipe protected by a coarse strainer is taken from the dam to the tank, and this latter must be at a sufficient distance from the burn in order to be out of the way of floods. By this arrangement only the quantity of water required for the turbine passes into the straining tank, the surplus which is not required continuing its usual course. The connecting pipe being very large, the velocity of water is too slow to allow of any sand or *débris* being washed along into the tank, and in this way the turbine is only fed with clean water. In addition to a water supply for power, this system has also been successfully adopted for purely domestic purposes.

Water-power schemes may be divided under three headings—*first*, those which are obviously insufficient, or which it certainly would not pay to utilise; *secondly*, those which require careful estimating and consideration as to whether the outlay would be warranted; *thirdly*, those cases in which the local conditions are so extremely favourable that there is no question as to the advantage to be gained. It is the business of the engineer to discriminate between these varying conditions and advise accordingly. Only lately the author had to reject a most tempting water-power scheme on account of the heavy outlay which its utilisation would necessitate.

When all is said and done the capital outlay to provide an efficient and reliable water-power is practically the sole factor in determining its adoption. If the first cost is not too great, water as a source of power is superior to every other. From a mechanical point of view the movement is purely rotary, which is naturally more efficient and steady than the reciprocating action of a steam or gas engine. The attendance required is less, the cost of all fuel and cartage is saved, and the depreciation of pipes and turbines is certainly lower than with engines and boilers. No ugly chimney stalks are required, and the buildings altogether are of a much simpler character. There is also an entire absence of steam, noise, and smoke. On the Continent there may be seen rows of turbines of 800 H.P. to 1,000 H.P. working at full power in almost perfect silence.

In this paper the question of water-power governing has not been touched upon. In America, say at Niagara, and also in Switzerland, this difficult question has been most successfully tackled. In the author's own practice it has not been found necessary to use automatic regulation, as with every turbine put down electric storage has invariably been employed, and under these circumstances a governor is not required; in fact, its absence is an advantage. The combination of an ungoverned turbine and dynamo with electric storage is a very strong and effective one. When the water is turned on at first the full charging current is obtained, but as the pressure in the cell rises the current automatically decreases, and when the cells are full this decrease is very marked indeed.

The striking feature of water-power plant is its simplicity, and the great thing to do is to utilise this to the fullest extent by adopting automatic lubrication throughout, such as ring lubricators for the dynamo and turbine bearings, and water lubrication for the stuffing glands. It is then quite easy to arrange the plant to run day and night. The author has several installations where this continuous system is in vogue, and it is especially advantageous where the electric current is used for power purposes as well as electric lighting. The reason for this is that where electric motors are used for sawing or threshing, the power is frequently required early in the morning, but in ordinary circumstances this is just the time when the accumulator is at its lowest, and to take a heavy discharge from it under these conditions is disastrous. On the other hand, by charging at a low rate day and night by the morning the cells are fully charged, and heavy currents may be taken from them for motive purposes without damage. Also the regulation is simplified, the charging and discharging switches are put on the same contact and there they stop.

Under these circumstances it becomes a matter of interest to inquire after the voltage, but as a matter of fact, working at a low rate in this manner, the variation is not found in practice to be great—perhaps a few more lamps per annum may have to be replaced. As far as the accumulator is concerned this is the most efficient way of working, and the life-time of cells worked by water power under these conditions is distinctly longer than in the case where the current is kept constant. In those cases where steam or gas engines are employed, the author tries as far as possible to achieve the same conditions, by reducing the current as the charging progresses. The best results of all have been obtained when the accumulator cells have been charged with a current far below the list rates. In many cases the lifetime of the accumulator has been doubled by charging at half rate, and as the man in charge has not to be in constant attendance, as a rule it does not matter whether the cells take five hours or ten hours per day to fill.

General Remarks.—In this country up to the present time there is not a single instance of water-power being used on a large scale, such as is found abroad, for the purpose of electric generation and transmission.

It must be recollected that the local conditions are not the same. On the Continent—for instance, in Switzerland—the price of fuel is very high indeed, ranging in many cases from £2 per ton upwards. It therefore pays in these circumstances to utilise the water-power at command to the fullest extent.

There is no doubt whatever that the statement which we hear so

frequently made concerning the enormous amount of water now running to waste in this country is perfectly true, but until its utilisation can be shown to pay from a commercial point of view, the water will remain unutilised. The tides also which ebb and flow in our rivers and estuaries will not be taken advantage of until it can be shown that the interest on the capital required for their utilisation is less than the cost of fuel required to generate the same power. The author's own feeling is that, as regards the development of water-power on a large scale in the future, it will be on the lines of electric generation and transmission to the nearest sea-board, where convenient sites for harbours and works can be obtained. A scheme of this kind has the advantage of offering cheap sites for works and power at a moderate cost, and in the most efficient form, and also that the raw material and finished products can be cheaply conveyed to and from the works.

Water power, however, is extensively used in this country for private works and installations, such as driving mills, saw-benches, farm machinery, and other similar purposes, and also for driving dynamos for the supply of electric light and power. Of these latter applications, the author has had no inconsiderable experience, and in one district alone in the West of Scotland he has had 15 working with the most excellent results, some for 10 or 12 years.

In these private installations it is of great advantage, when a sufficient supply of water has been obtained, to utilise it not only for electric lighting, but for other domestic purposes. In many cases a threshing mill or saw-bench can be driven direct off the turbine itself, by fixing an extra pulley on the shaft, or it may be necessary to employ electric motors at a distance. The value of these subsidiary applications is often very great. To take a single instance: the proprietor of an estate of considerable size with plenty of timber (which only realised a small price when sold) was in the habit of buying finished wood for fencing and other estate purposes. However, a saw-mill was built at a convenient site, some half a mile distant from the turbine, and provided with a motor of 15 to 20 H.P. The result is that now the whole of the timber of the estate is used for home purposes, and a cross-cut saw in a few days provides enough fire-logs for the winter's use. The saving effected by this arrangement is sufficient to pay for the interest on the cost of the whole installation, including the lighting of the mansion-house. The turbine in this case was a 30 H.P., working under a head of 8 feet.

It is certainly remarkable at the present time to witness the many uses to which electricity is applied. As an example of the various applications of electricity, the author may mention those in connection with one of his recent installations:—(1) Electric lighting, 200 lamps; (2) electric bells; (3) telephones connecting house, stables, and farm; (4) electric clocks, controlled by standard clock in hall; (5) electric heating by means of radiators; (6) electric cooking; (7) pumping water required for house and farm; (8) driving farm machinery, consisting of corn mill, turnip pulper, and chaff-cutter.

The two difficulties met with in water-power practice are—(1) during the autumn through leaves gathering on the strainer and stopping the flow of water to the turbine; and (2) snow and ice in winter. The first difficulty can best be dealt with by fixing strainers of very large size at the mouth of the pipe, so that frequent journeys by the attendant may be avoided; the second (snow and ice in winter) can only be dealt with by breaking up the ice in order to clear the lade, and providing for the disposal of the broken ice. At Fort William, for instance, where there is an exposed lade for three-quarters of a mile, it is necessary, as a rule, after two or three weeks' prolonged frost, to engage an extra man to assist in keeping the lade clear. The lade at the lower end is broadened out to form a catch-pit, on the river side of which a long overflow is provided. There is a very steep fall from the overflow, and the broken ice is hauled out and over it by means of rakes. Sometimes it is also necessary to open the side sluice for the quicker disposal of the broken ice.

Towns.—There are many towns in Scotland where water-power is available, which will be taken advantage of when the members of Urban Councils realise the economic advantages for electric lighting and power which lie at their door. If the present high price of fuel is maintained, the more marked will be the advantage to be derived from using water-power.

In conclusion, one further consideration may be submitted. Whether coal or water-power is used, the power of both is obtained from the sun; but there is this distinction: in the case of coal, the potential energy of the sun stored up in countless ages past is being utilised; whereas, in the case of water-power, the energy of the sun exercised only yesterday in evaporating the water of the ocean is perhaps being used by us to-day for driving our turbines and dynamos.

APPENDIX.

The following simple formula has been applied in the author's own work with results confirming its practical correctness for determining the size and gradient to be given to the lade. This formula has been made out and checked by Mr. John Paterson, civil engineer, from numerous tests made under varying conditions.

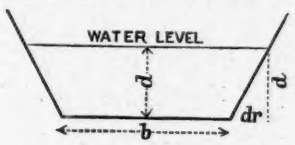
To Calculate the Dimensions and Gradient of a Lade when Discharge in Cubic Feet per Second is Given.—(All dimensions are given in feet.)

Put b = breadth of base of lade.
„ d = depth of water in lade.
„ r = inclination of slopes of lade (horiz. over vert).

Area of water section or A is = $(b + r\,d)\,d$, then $b = \frac{A - r\,d^2}{d}$.

Wetted perimeter is $= b + 2\,d\,\sqrt{1 + r^2}$.

Hydraulic depth is $\frac{\text{Area of water section}}{\text{Wetted perimeter}}$



SECTION OF LADE.

$$\text{Area of water section or } A = \frac{\text{Discharge}}{\text{Velocity}}.$$

$$\text{Put } s = \text{gradient of lade} = \frac{\text{Fall}}{\text{Length}}.$$

Then

$$v = \sqrt{K\,s \times \text{hyd. depth}} \text{ or } s = \frac{v^2}{K \times \text{hyd. depth}} = \frac{1}{\frac{K}{v^2} \times \text{hyd. depth}}$$

K is a constant which varies with the nature of the soil and the hyd. depth of the lade.

1. *For Small Discharges of* 10 *Cubic Feet per Second and Under.*—Depth of water in lade should be made 1 to 1½ feet. Mean velocity 2½ feet per second. The slopes of the lade will depend upon the nature of the ground, but as a rule ½ to 1 will be ample. The value of K for ordinary ground will be 3,250.

$$\text{Gradient} = \frac{1}{\frac{3{,}250}{(2{\cdot}5)^2} \times \text{hyd. depth}} = \frac{1}{520 \times \text{hyd. depth.}}$$

$$\text{Area of water section} = \frac{\text{Discharge}}{2\frac{1}{2}}; \text{ value of } 2\sqrt{1 + r^2} = 2{\cdot}24.$$

2. *When the Discharge varies from* 10 *to* 20 *Cubic Feet per Second.*—Depth of water should be made 2 feet. Velocity 2½ feet. Slopes of lade ½ to 1. The value of K in ordinary ground may be taken at 3,500.

$$\text{Gradient} = \frac{1}{\frac{3{,}500}{(2{\cdot}5)^2} \times \text{hyd. depth}} = \frac{1}{560 \times \text{hyd. depth.}}$$

$$\text{Value of } 2\sqrt{1 + r^2} = 2{\cdot}24.$$

3. *When the Discharge varies from* 20 *to* 40 *Cubic Feet per Second.*—Depth should be 2½ feet. Velocity 2½ feet. Slopes of lade 1 to 1. Value of K, 3,750. Gradient $= \frac{1}{600 \times \text{hyd. depth.}}$

$$\text{Value of } 2\sqrt{1 + r^2} = 2{\cdot}83.$$

4. *When Discharge varies from* 40 *to* 100 *Cubic Feet per Second.*—Depth should be 3 feet. Velocity 3 feet. Slopes 1½ to 1. Value of K may be taken at 4,000. Gradient $= \frac{1}{450 \times \text{hyd. depth.}}$

$$\text{Value of } 2\sqrt{1 + r^2} = 3{\cdot}6.$$

5. *When Discharge varies from* 100 *to* 350 *Cubic Feet per Second.*—Depth should be 3½ to 5 feet. Velocity 3 feet. Slopes 1½ to 1. Value of K, 4,250. Gradient $= \frac{1}{475 \times \text{hyd. depth.}}$

$$\text{Value of } 2\sqrt{1 + r^2} = 3{\cdot}6.$$

6. When the discharge exceeds 350 cubic feet per second the value of K varies from 4,500 to 5,500 as the hydraulic depth varies from 3½ to 5 feet. Beyond these limits the lade actually becomes a deep river, and its discharge and gradients should be calculated by more elaborate formulæ, which it is unnecessary to detail in the present paper.

The following two simple working formulæ are easily remembered, and are specially useful when results have to be worked out quickly on the spot.

The first is the quantity of water required per horse-power with a given fall, after allowing for loss in turbines, &c.

Let Q = the quantity of water in cubic feet per minute; h = head in feet; H.P. = horse-power;

$$\text{Then } Q = \frac{\text{H.P.} \times 700}{h}.$$

Again to find the size of pipes approximately for small pipes up to 10 inches; the diameter is conveniently found by taking the square root of the number of cubic feet per minute, and the result gives the diameter of the pipe in inches. Thus, for instance, if to give the necessary power 100 cubic feet of water is required, a good working size of pipe would be 10 inches. For 50 cubic feet of water per minute a 7-inch pipe would be necessary.

For a larger quantity of water and larger pipes the quantity of water should be halved, and then the square root taken. Thus for 800 cubic feet of water per minute the square root of 400 would give the working size, viz., 20 inches.

Cast-iron pipes are usually employed up to 15 inches or 16 inches diameter, but for larger sizes steel pipes may frequently prove more

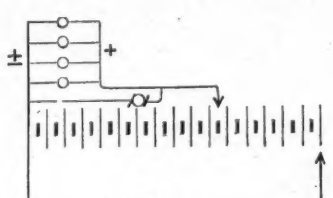
advantageous. They are much lighter, and are usually supplied in 20 feet lengths. The joints for cast-iron pipes are made in the usual manner with gaskin and lead. For flanged steel pipes a rubber ring is employed.

LARGE STORAGE BATTERY AT KANSAS CITY.

In order to provide for the coming winter load at Kansas City it became absolutely necessary that some means be provided to relieve the main generating station, and, from an article in the New York *Electrical World*, we gather that it was decided that the best way of effecting this was by an accumulator, partly because it could be quickly erected and partly because it would suit the scheme of extension contemplated by the company.

There are two batteries each of 800 ampere-hour capacity on a one hour discharge, one being connected on either side of the three-wire system. There are 70 cells in each battery and 20 of these are end cells.

Each cell consists of 20 positive and 21 negative plates contained in a lead-lined wooden tank 44 inches long 18½ inches wide and 19 inches deep. Three glass rods separate each pair of plates which are 14½ inches × 9 inches. A clear space of 2 inches is allowed between the plates and the tank lining.



METHOD OF CHARGING END CELLS.

The end cells are all connected to the end cell switch in an adjacent room by copper bars ⅜ inch by 2 inches lead-coated.

The end cell switches are worked by Lundell motors.

A duplicate arrangement is fitted on each end cell switch so as to admit of some of the end cells being charged while the battery is in service. A separate pair of generators is run whenever it is necessary to charge the end cells. The method is shown in the accompanying diagram.

Provision is made in the end cell switch contact to prevent short-circuiting by dividing the contact into two parts, these being connected by a suitable German silver wire shunt.

It is expected that this battery will carry the peak of the load for about two hours on winter evenings.

INSTITUTION OF ELECTRICAL ENGINEERS (NEWCASTLE SECTION).

THE DEVELOPMENT OF THE DENSITY FACTOR.

By C. TURNBULL, Borough Electrical Engineer, Tynemouth.

The density factor of an electricity works may be defined as the number of 8 C.P. lamps connected per £1 worth of mains laid; or perhaps, better as the number of units sold per annum per £1 worth of mains laid. Mains in this case should include transformers and the like. Owing to the great cost of every yard of cable laid, it is of the utmost importance to have a good density factor; indeed, it may be said, take care of the density factor—*i.e.*, get the mains loaded up with every kind of consumer within reach—and the load factor will take care of itself.

The density factors of the following towns taken at random from "Garcke's Manual" will serve to show the great differences that exist.

	8 C.P. lamps connected per £1 worth of mains.	No. of units sold per ann. per £1 worth of mains.
Aberdeen	1·21	7·8
Brighton	1·03	25·4
Derby	·89	17·5
Edinburgh	1·12	20·6
Harrow	·64	6·5
Manchester	·94	18·8

The cost of transformers is not taken into account in the above as it is not shown separately in the "Manual." Seeing that the mains represent some 40 per cent. to 50 per cent. of the capital expenditure, I think the figures worthy of consideration.

RENTED WIRING.

To meet those who do not wish to be at the expense of wiring their premises, it has been proposed to take the mains throughout the building instead of stopping them at the meter only, and to charge a proportionately increased rate for the current consumed to cover the cost. This method is not entirely satisfactory, especially seeing that the modern tendency is to make consumers pay a fixed sum per annum to cover standing charges with a comparatively small charge for current used.

I would suggest that the following points are desirable in a system of rented wiring.

For a plain fitting including lamp and switch complete, a fixed quarterly rental should be charged.

Additional fittings on the same switch should be charged at a second and lower rate.

Additional lamps on a fitting not having independent switches should be charged at a third and still lower rate.

The hirer should have the option of hire, purchasing the installation at rates based on the rentals; or he should be allowed to purchase outright at any time for a reasonable sum.

When the station does the wiring, the rentals, &c., may be fixed by examination of the average costs of installation, but personally I prefer to have the work done by a wiring firm. Wiring needs more supervision than most resident engineers are prepared to give, and with smaller stations, at any rate, there would not be a sufficient flow of work to keep an efficient staff busy, unless outside firms were discouraged, which would be foolish.

When wiring is done by contract, the terms must be settled by bargain. In Tynemouth we have arranged with a private firm to do the work, we to collect their rentals. A plain fitting complete costs 5d. per quarter, or without a separate switch 4d. per quarter, while an additional lamp on a fitting costs 3d. per quarter. Double these rates will pay off the cost in 4½ years, or 1½ times these rates will pay it off in 6½ years; or the hirer may buy at any time at a moderate price.

Of course, these terms are not suitable for large houses, and in many towns special arrangements would have to be made to meet special cases. But it is to be observed that rented wiring is intended mainly for small consumers.

THE TWO-METER SYSTEM.

It has always been a trouble with the maximum demand system that consumers are in fear that their accounts will go up with a jerk if they happen to put on extra lights some night. This has been met in various ways, such as by allowing the indicator to be short-circuited on special occasions, or by having two-way switches arranged so that if one lot of lights is switched on, then another lot will be switched off. In many cases people will only wire a few rooms in their houses to make sure that they will not at any time be let in for a big bill. It has been proposed to meet the difficulty by having two meters, one to register during the hours of heavy load, and the other during the hours of light load, the units registered by the latter being charged at a lower rate. On examination, this will be found unsatisfactory, for a shop, which, say, averages two hours a day throughout the year, will be charged at the high rate, although undoubtedly a good customer, while an office which occasionally overlaps the station maximum demand, and only takes the current during the winter months, will get off at far too light a rate.

I would suggest to you that houses which have a g od steady load throughout the year will not appreciably increase the station maximum demand by having bedroom and other short-hour lights connected up, in addition to their long-hour lamps, nor will they require any heavier mains. It is, therefore, worth while to do something to rid their owners of the fear of a largely increased maximum demand if the occasional lamps are connected up. This can be done by allowing consumers to have two meters, one for long-hour lights, and the other for the remainder. The units registered by each meter are charged as if for separate consumers, so that practically, the full rebate is obtained on the long-hour lights, and no rebate on the occasionally used ones. A small extra rent may be charged for the second meter, which may generally be one of the cheaper types now coming into use. It is also possible as a rule to omit the demand indicator, as, of course, the demand on each meter is the full number of lamps connected thereto.

This concession has the effect of relieving people from anxiety so that they wire their houses freely, and will, I doubt, not use their lights freely too.

BOILERS IN ELECTRICITY SUPPLY WORKS.

THE contributed article on page 83 of last week's issue of the ELECTRICAL REVIEW has given us an opportunity of examining, more or less closely, into some matters connected with electricity supply stations, and bringing some information before our readers in a concise and comprehensive form.

Our correspondent's reference to the Babcock & Wilcox boilers was evidently intended to apply to London and surrounding districts, and not to the provinces, as we will endeavour to show.

We have examined the sources of information open to us in book or tabular form, and we find that the boilers in the electricity works of the kingdom are designated as Babcock and Wilcox, Water-tube, Lancashire, "Economic," Loco., Multitubular, Marine, Semi-portable, Dryback marine, Cornish, &c.

Those coming under the category "Water-tube" are, in almost every instance, Babcock & Wilcox, so our analysis leads us to the following approximately correct conclusions:—

In London and the London district there appear to be about 505 boilers in works now in operation, and about 31 in works in progress. In provincial electricity supply stations now operating there are 868 boilers, and 113 in those progressing, or a grand total for the United Kingdom of 1,517.

In and around London the Babcock & Wilcox boilers in action and in progress number probably 360, and Lancashire boilers about 35.

In the provinces, on the other hand, Lancashire boilers erected or being put in, total up to 470, Babcock & Wilcox coming second with about 300.

These two, then, together account for no less than 1,165 boilers, leaving 352 scattered between the remaining types above enumerated.

It must be understood that we make no mention here of the boilers which are to be employed in projected stations, metropolitan and provincial, over a score in number, nor of electricity supply undertakings, 50 or more, in the "report" condition.

We have been at some trouble to get at these approximate figures from a mass of statistics, and we cannot help calling attention to one of our means of obtaining data.

We pinned a certain sheet or table on a wall, and then had to reverse it, as it is printed on both sides. This repeated several times gave rise to a feeling of irritation, and we then spread it on the largest table at our command. Leaning across this to get at the top end was most uncomfortable, and the lower part still overlapped the table to the extent of about a yard, so we had either to stoop to read the lower portion or let the top end hang over a similar distance. We quickly tired of this and then spread the sheet on the floor, when by reclining at full length upon it at times, kneeling at others, which brought on "housemaid's knee," we achieved the above result, but, alas! at the cost of the sheet, which gradually opened up at its manifold foldings, and now lies before us ragged and torn. Stronger paper we would suggest might overcome this latter difficulty.

There are probably well-established causes to account for the practical monopoly of the Babcock and Wilcox boilers within the metropolitan area, just as there are to give the Lancashire boiler the premier position in the country; in any case, the figures are interesting to central station engineers and boiler makers, and show that there is still plenty of work in readiness for these latter in the stations about to be erected all over the country; and, as many of these are far away in the provinces, it is possible that in another 12 months the grand total of Lancashire boilers will approach more nearly, if it does not overlap, the figures credited to boilers of the Water-tube variety.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

5. "Electric refrigerators or apparatus for cooling air, vapour, or liquids by means of electric currents." H. A. KENT. Dated January 1st.

17. "Improvements in electric glow lamps." G. H. SMITH. Dated January 1st.

18. "Improvements in electric switches." G. W. HOLT. Dated January 1st.

31. "Improvements in switches for electrical purposes." A. WATSON. Dated January 1st.

34. "Improvements in electrical wall plugs, plug connections, and the like for electrical purposes." G. SPERRYN and W. H. WOOD. Dated January 1st.

42. "Means for the generation of electrical energy by the liquid oxidation (or other non-ignition decomposition) of coal or carbon and for the utilisation of the electricity and chemical and or other combination produced thereby." R. H. DUNN. Dated January 1st.

56. "Improvements in the electrolytic deposition of metals." H. C HARRISON. Dated January 1st.

62. "An improved coin feed apparatus for telephones and other purposes." C. J. BAYARD and A. E. LAMKIN. Dated January 1st.

65. "A safety appliance for overhead electric wires." P. L. R. FRASER. Dated January 1st.

74. "Improvements in switches for controlling electrical circuits." A. P. LUNDBERG and G. C. LUNDBERG. Dated January 1st.

90. "Device for regulating electric motors." M. MONTHIERS. Dated January 1st.

131. "Improvements in electric light switches." A. P. LUNDBERG and G. C. LUNDBERG. Dated January 2nd. (Complete.)

134. "Improvements in gearing for electric clocks, checking instruments, and for indicators and the like." J. J. STOCKALL. Dated January 2nd.

157. "An improved electric motor." D. PERRET. Dated January 2nd.

165. "Improvements in electric telegraph transmitting apparatus." G. K. B. ELPHINSTONE. Dated January 2nd.

180. "Improvements in telephone index boards." A. DAVIDSON. Dated January 3rd.

187. "Improvements in electrically-propelled vehicles." R. E. MIDDLETON. Dated January 3rd.

202. "Improvements in or relating to fittings for incandescent electric lamps for illuminating shop windows, or for other analogous purposes." A. W. REUTTELL. Dated January 3rd.

217. "Improvements in or relating to electrolytic current interrupters fo X ray work." H. W. C. COX. Dated January 3rd.

257. "Electrically-played banjo or like stringed instrument." J. H. GORDON and W. ROSS, jun. Dated January 4th.

266. "Improvements in brushes for dynamos and the like." J. MATTHEWS and W. DAVIES. Dated January 4th.

275. "Improvements in electric switches." C. W. S. CRAWLEY. Dated January 4th.

294. "Improvements relating to galvanic cells or batteries." M. M. BAIR. Dated January 4th.

310. "Improvements in electrical switches." A. E. RICHARDSON. Dated January 5th.

333. "Improvements relating to electric motors." P. M. LE HEGARET. Dated January 5th.

340. "Improvements in electro-magnetic apparatus for winding clocks or timepieces." L. KUSNICK. Dated January 5th.

ELECTRICAL PATENTS OF 1886 EXPIRING JULY TO DECEMBER, 1900.

We are informed by Messrs. W. P. Thompson & Co. that a large number of applications were filed in July to December, 1886, but some of these were never completed, and of those that were only 15 were maintained to run their full term, viz.: 14 years. These being of considerable interest we give a short abstract of them below:—

5,168. "Improvements connected with the electric lighting of trains." R. E. P. Crompton and J. Swinburne. Dated April 14th, 1886. Relates to dynamos for lighting railway trains. The dynamo is driven from the axle of the carriage through a countershaft, and is in connection with secondary cells. The field magnets are wound with two wires as if the dynamo were an ordinary shunt machine working at about 500 revolutions. The lamps are in shunt to the armature, but the cells are so connected up with the second wire, that if the dynamo charges them the current traverses this wire and demagnetises the field magnets. If, therefore, the speed increases above 500 revolutions, the dynamo charges the cells, but the pressure on the lamps does not increase. If the speed falls below 500 revolutions, the cells supply part of the current to the lamps, and in doing so, magnetise the field more strongly. When the speed falls below a certain number of revolutions, a cut-out breaks the armature connections. To allow the dynamo to reverse with the train, the tangent brush carrier is mounted on the axle, so as to turn with it, until adjustable stops hold the brushes in the right position for the direction of rotation. 3 claims.

9,016. "Improved apparatus for measuring the efficiency of an electric circuit." Sir W. Thomson. Dated July 10th 1886. Relates to apparatus consisting of an inspectional magneto-static current meter used in connection with special adjustable resistance coils, and an electro-dynamic balance with electrolytic apparatus for determining its constant, by which the coefficient of the current meter is at any time determined in terms of constant units. 18 claims.

9,214. "New or improved means and apparatus for the manufacture and coating or covering various metal wares by combined electro-chemical and mechanical process." F. E. Elmore. Dated July 15th, 1886. The invention relates to the manufacture of various metal goods by electro-deposition; for instance, it relates to tinning or galvanising metal sheets, or to the manufacture of metal sheets, or to coating or manufacturing wire of copper, &c. The metal is deposited while the cathode is passing through a bath, and the deposited metal is rendered smooth and coherent by the action of burnishers of glass, agate, &c. A depositing tank is described for coating metal sheets, which may be in continuous lengths or not. Two feed tables from which the plates are passed through the tank from left to right are provided. The edges of the plates are guided by pairs of discs, the lower discs being flanged; the discs are driven by worms. The plates in their progress are burnished by burnishers carried by reciprocating cross-bars, which are actuated from the main shaft by pins on discs working in vertical slots in arms connected with the framing. The burnishers may be so arranged that one set acts when moving in one direction and the other set when moving in the other direction. Metal sheets may be made in continuous lengths in a manner similar to the above. The specification contains a tank containing an endless metal sheet mounted on rollers, on which a non-adherent deposit is first produced; when the deposit is sufficiently thick the sheet thus produced is led to and fro over rollers, passing between anodes and receiving a further deposit, the surface being burnished by burnishers placed at the bends. In coating wire a grooved rotating drum is used, which is surrounded by a number of plates forming anodes. Each wire as it is unwound from the drum is burnished by rotating burnishers. The wire may be formed in continuous lengths, being initially deposited in the grooves; the circular form may be given to the wire by drawing it through suitable dies before it passes to the burnishers. 5 claims.

9,708. "New or improved apparatus for automatically making and breaking circuit for a dynamo charging accumulators, also applicable for use in running two or more compound-wound dynamos in parallel circuit." A. B. Holmes and J. C. Vaudrey. Dated July 27th, 1886. The invention consists in devices for automatically completing the main circuits of dynamos charging accumulators, or running in parallel, when the speed and electromotive force have risen sufficiently. The circuit is completed by the action of coils connected with the shunt field circuit of the dynamo. 2 claims.

10,241. "Improvements relating to the welding of metals, and to apparatus therefor." H. H. Lake. (E. Thomson.) Dated August 10th, 1886. The welding of metals is carried out by pressing the parts to be united against each other, and passing an electric current through them, the resistance at the place of contact of the metals producing a welding heat. The figure shows one form of apparatus used. The bars to be welded are held by clamps in levers which are hinged together, and which are insulated from each other by mica, or other material placed in the joint. The levers are forced towards one another by a spring adjusted by a screw and a nut. A screw is used for holding the levers apart during the setting of the bars, and may act as a shunt to divert the current when the weld is completed. The current is conducted from any suitable

source of electricity by wires to an induction coil with an iron core. The secondary coil consists of a few turns of coarse wire, which is connected to the levers by cables. A special induction coil is described, for use with alternating currents, consisting of a ring-shaped primary coil of wire surrounded by a concentric bar of copper, the extensions of which form the levers, and which is reduced at one part to give flexibility, the current being shunted over this reduced part by cables. The primary coil and the copper bar are surrounded by iron wire, or by strips of sheet iron. The bars may be heated at or near the junction by a blowpipe flame to prevent radiation, and to increase the resistance. The two ends of a bar may be joined together to form a ring, and drills and bolts may easily be lengthened, and the shanks of drills, taps, and reamers, may be welded. The apparatus may also be used in manufacturing chains, pipes, hoops, and rings, wheel tyres, and edge tools. 11 claims.

11,853. "Improvements in apparatus for projecting a beam of light." R. A. Scott. Dated September 17th, 1886. Search lights.—Relates to the mechanism for rotating the lantern upon horizontal and vertical axes. The lantern is rotated by means of an electromotor, which is controlled from a distance, and drives three shafts through worm and bevel gearing. The lantern is turned upon its vertical axis by completing the circuit of an electro-magnet. One end of the pivotted armature forces a wheel which slides along, but is keyed to first shaft into gear with a wheel riding loosely upon the third shaft. This wheel gears with an internally-toothed wheel rigidly attached to the cover which consequently rotates horizontally upon anti-friction rollers, and carries the lantern with it. To rotate the lantern upon its horizontal axis, the circuit of an electro-magnet is completed, causing a clutch to grip a worm-wheel, thereby driving the third shaft and pinion, the latter gearing with a circular rack attached to the lantern. 4 claims.

11,877. "Improvements in induction coils." W. Stanley, jun. Dated September 21st, 1886. Relates to transformers. The primary and secondary coils of induction coils or converters are formed into a circular or polygonal annulus. They are embraced by iron discs, each of which has a radial slot; the discs are sprung on the coils by opening the slots. 2 claims.

11,878. "Improvements in induction coils." W. Stanley, jun. Dated September 21st, 1886. Relates to induction coils. The conductors form flat coils wound in slots in a number of iron plates. Between iron plates of approximately rectangular shape the plate washers are placed, the whole being secured by bolts. The primary and secondary coils are wound in a single layer in deep slots in the plates. In another arrangement the plates radiate from a centre, each having only one slot. The outer portion of the slots may be wider than the inner, admitting a thicker conductor. 5 claims.

11,879. "Improvements in induction coils." W. Stanley, jun. Dated September 21st, 1886. Relates to induction coils. The cores are constructed so as to form nearly closed magnetic circuits, the resistance of which can be varied to some extent so as to vary the electromotive force of the secondary coil. A transformer is described with a nearly-complete ring core, at the ends of which are non-magnetic projections through which an adjusting screw works. By means of this screw the ends of the core can be made to approach or recede as required. In another arrangement, the resistance of the magnetic circuit may be varied by a screw varying the position of a piece of soft iron entering between the ends of the core. 3 claims.

12,097. "Improvements in electrical communicating apparatus applicable for use in navigable vessels and other purposes." W. Chadburn. Dated September 23rd, 1886. Relates to an order or alarm apparatus for ships or for other purposes. The communicating apparatus is provided with dial transmitting and receiving instruments bearing similar orders or signs, a separate circuit being provided for each order, &c., to be transmitted. The circuits are made and broken in the transmitter by suitable means, and operates a reversible magneto-electric motor in the receiver which brings a pointer up to the order, &c., transmitted, where it is held locked. The motor may be energised in any suitable manner. Such apparatus may be used as an engine room telegraph, or by actuating a suitably arranged transmitter from the rudder of a vessel, it may be used as a steering telegraph. 9 claims.

13,340. "Improvements in tubes or conduits for laying underground electric conductors, and in insulating coverings for electric conductors." H. E. Newton. (E. D. McCracken.) Dated October 19th, 1886. Conduits for underground electric conductors and insulating coverings for electric conductors are formed of spiral layers of vegetable paper secured together by a vulcanisable adhesive compound. 5 claims.

13,341. "Improvements in machines for covering and insulating electric wires." H. E. Newton. (E. D. McCracken.) Dated October 19th, 1886. Conductors are covered with strips of paper or other suitable material, one face of the strips being coated with adhesive material; a fine wire may also be wound spirally round the main wire. The wire is fed under tension from a drum (with a brake) through a hollow shaft mounted in bearings. The hollow shaft is continued as a frame journalled at one end in a bearing. As the wire passes through the frame it is straightened by the fingers and receives the paper strip from the spool. An adhesive material is applied to the strip from a reservoir attached by adjustable guides to a slotted plate on the shaft. The paper spool is held on an adjustable arm on the shaft. Fingers are arranged to press and consolidate the strips on the wire. After passing through the hollow journal the wire is led past one grooved drum to another grooved drum driven by gearing, then to and fro between the drums, and finally to a winding-drum driven by a loose belt. The grooves on the wheels are deeper on one side than the other. The shaft with its appurtenances is rotated by gearing from the shaft. When it is required to wind a wire spirally between any of the paper spirals, a bobbin of wire is supported on a frame attached to the shaft and the wire is fed round a tension regulator to the wire in the rear of the paper feed. 11 claims.

14,757. "An improved dynamo-electric machine." W. Lahmeyer. Dated November 13th, 1886. Relates mainly to the field magnets. The cores are short and thick; they are either cast with the rest of the frame, or they consist of wrought-iron and have the rest of the frame cast round them. The coils are slipped over the cores before the armature is mounted in its place. The arrangement of the magnets is such as to offer small magnetic resistance, while the wasted field is small. The armature and parts of the frame have ventilating openings. There are perforated iron plates at the ends of the machine, which serve as a protection from injury. 2 claims.

15,579. "Improvements in the manufacture of porous earthenware." H. J. Allison. (C. C. Gilman.) Dated November 30th, 1886. Relates to insulating compositions. A composition in varying proportions of clay, short-cut straw, and sawdust or similar granular vegetable material is dried and fired to form a porous earthenware material which may be used as an insulating composition. 10 claims.

15,831. "Improvements in or connected with means and apparatus for the deposition or obtainment of metals by electrolysis." F. E. Elmore. Dated December 3rd, 1886. Relates to a method of obtaining a compact metallic deposit from solutions or fused salts, which consists in burnishing the metal as it is being deposited, and in dispersing the gas bubbles formed on the cathode; the method is especially applicable to the case of metals, such as zinc, which tends to form a loose deposit. The cathodes may consist of discs mounted on a shaft which is kept in continuous rotation parallel with the shaft is placed a rod carrying the burnisher, this rod being mechanically raised and lowered so as to burnish the whole surface of the cathodes. Near the rod are also pipes with perforated branch pipes between the cathodes through which the electrolytic liquid is forced against the surface of the cathodes, so as to remove bubbles of gas; or rubbers or brushes may be used for this purpose. The metal is thus caused to deposit in a compact form which is suitable for melting. 4 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

2,849. "Improvements in electro-magnetic apparatus for separating ores." E. Kreuser. Dated February 8th, 1899. An electro-magnetic separator for treating ores is provided with two oppositely-rotating iron cylinders which are of I or T cross-section, and are wound as bar magnets. The cylinder has flutings on its poles, and the lower cylinder has its polar surfaces covered with diamagnetic material. The one cylinder may be mounted vertically above the other. The shafts are preferably made of brass, papier mâché, vulcanite, or other non-magnetic material, and are formed with terminal discs, bolted to the cylinders. The cylinder is driven by means of gearing, and drives the cylinder by means of a ring which rolls upon a disc on the cylinder, these rings are made of non-magnetic material, and serve to keep the cylinders at the required distance apart; the discs are removably secured to the cylinders. The ores are supplied from hoppers to small hoppers whence the ores pass to the magnets; the small hoppers are fitted with adjustable slides. The non-magnetic materials are discharged into hoppers and bags, the strongly magnetic ores pass along a trough, and the weaker magnetic ores are discharged along a trough. The first trough is adjustably mounted within the second trough which is also adjustable by means of a rack and pinion. In a modification, the lower cylinder is not magnetised, and is not provided with diamagnetic coverings, and, in a second modification, the cylinders may be so wound that each has terminal poles and an intermediate pole, which may be larger or smaller in diameter than the terminal poles for the purpose of dispensing with distance-rings. 4 claims.

2,872. "Improvements in telegraphy." J. Jasinski. Dated February 8th, 1899. Relates to arrangements for transmitting from one or more automatic transmitters on to one or more series of lines the receiving-stations of which are provided with Morse instruments only. The switch is connected to an automatic transmitter and the relay, &c., apparatus attached to one line for sending Morse signals of one sign only in place of the currents of both signs used in automatic transmission. Several such relays, connected to separate lines, may be arranged in series, the separate lines working on open or closed circuit methods. The specification further describes a relay having an insulated leaf spring contact on its armature for use in duplexing, and also the method of duplexing with a relay. 3 claims.

2,906. "Improvements relating to switch boards." C. H. Cox. Dated February 9th, 1899. The "bus" bars are divided into sections, each section forming a terminal for a switch cut-out or the like. The sections are connected by cables or connections in series. The invention is preferably used with a switchboard as described in Specification No. 14,514, A.D. 1898, in which a number of boxes are connected and supported by a tubular framework, the tubes forming conduits for the conductors. 4 claims.

3,005. "Improvements in and connected with electrical switches." W. H. Lane. Dated February 10th, 1899. Switches adapted for traction purposes with storage cells and provided with contacts for connecting up the batteries in series or parallel. One arrangement is adapted to give four combinations, *i.e.*, two speeds in either direction. Seven contacts are fixed on the base, and a number of contact arms are fixed on a spindle and suitably cross-connected. A spring controlled lever holds the switch in the desired position. 2 claims.

3,028. "Improvements in combined automatic magnetic circuit breakers and resistance controlling switch." H. H. Lake. (H. B. Cutter.) Dated February 10th, 1899. Resistance or controlling switches for motors, &c., provided with magnetic circuit-breakers for excessive or minimum currents. The circuit closing or switch arm is pushed into the contact against the spring, and held there by a catch engaging a pin. A solenoid is in series with the motor, and its core is adapted in cases of excessive current to act on a pin and lift the catch, so releasing the arm and opening the circuit. The resistance-switch arm tends always to return to the "off" position under the action of a spring, but is held in the "on" position by the electro-magnet also in series with the motor. Should the current fail, this magnet fails to hold the arm which flies back, so breaking the circuit. 3 claims.

3,032. "Improvements in printing-telegraph machines." The Telescriptor Syndicate, Limited, and A. L. Shepard. Dated February 10th, 1899. Relates to improvements in the class of printing-telegraphs described in Specifications No. 24,076, A.D. 1894, and No. 8,809, A.D. 1897. In the earlier specification, synchronising was effected by a special key which controlled the switch, but in the present arrangement the switch is operated by the lower contact frame being rocked downward when a key is depressed, and being released by the depression of the spacing key which trips the catch. The spacing key is also provided with a contact spring which slides down the conducting face of the projection but rises against its insulating face. The change key is also arranged to trip the catch. The escapement magnets are operated by the polarised relay. The magnet, operated by impulses, is provided with a contact spring acted upon by a cam on the armature shaft. The polarised relay is arranged with a contact in the local battery circuit; this contact is broken by impulses due to the receiver being out of synchronism and coming to zero. The bell is single stroke, and is arranged to sound by the synchronising currents, such sounds indicating that the receiver is out of agreement with the transmitter, and that the last word was not correctly received. 7 claims.

3,130. "Improvements in electric lamps." A. C. Brown. Dated February 11th, 1899. Relates to incandescent arc lamps. An arc lamp of any construction is provided with hollow electrodes of carbon, or platinum-iridium or other metal to receive a round, flat, or other rod of magnesia or other refractory material, which connects the electrodes, and after being heated by the arc carries the whole current, and is thus kept incandescent, the electrodes separating so far that the arc ceases. The rod may be placed loosely in the electrodes, or may be fixed in one of them. Each electrode may consist of two grooved strips, held together to enclose the rod. A stop is provided to limit the outward movement of the movable electrode. The current is limited by a choking coil or resistance in series with the lamp. The Provisional Specification describes also the use of carbons provided with fixed cores of refractory material, inserted as rods or compressed powder, instead of the single loose rod above described. 8 claims.

3,160. "Improvements in and relating to electro-magnetic cut outs and other like apparatus specially applicable to electric arc lamps." H. Smithson and E. R. Sharpe. Dated February 13th, 1899. Relates to means for cutting out an arc lamp or the like should the potential rise above the limit, and for introducing a compensating resistance. The lamp circuit is normally closed by a contact engaging the contacts. The contact is pivoted to a stand, and held in position by its projecting arm engaging the armature of an electro-magnet. Should the potential rise, the armature moves, and releases the arm which under the action of the spring breaks contact, and makes contact with the compensating resistance. 3 claims.

3,177. "Improvements in or relating to electrically illuminated advertising mediums or the like." W. T. Bell. Dated February 13th, 1899. Relates to switch mechanism for lighting electric lamps in succession so as to form words, such as is described in Specification No. 16,220, A.D. 1897. Wires in connection with the lamps are mounted in parallel lines on blocks under which are pins in which loops on the wire ends engage. The wires are suitably stretched by screw rods, and are connected with the lamps by wires. Contact is made with the desired wires to light the lamps in succession by means of serrated plates which are broken away where contact is not to be made, the serrations serving to keep the wires apart. The plates are removably mounted on a rotating skeleton drum consisting of longitudinal bars secured to end discs. In modifications, the contacts may be mounted on endless chains or slides, and they may be of star-wheel section mounted on arms on a rotating shaft. A device to prevent sparking consists of a contact bearing on a toothed disc provided with insulating blocks on which the contact rests while the plates are out of contact. 6 claims.